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Vol. 4.

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JANUARY, 1904.

PAGE'S MAGAZINE

weekly

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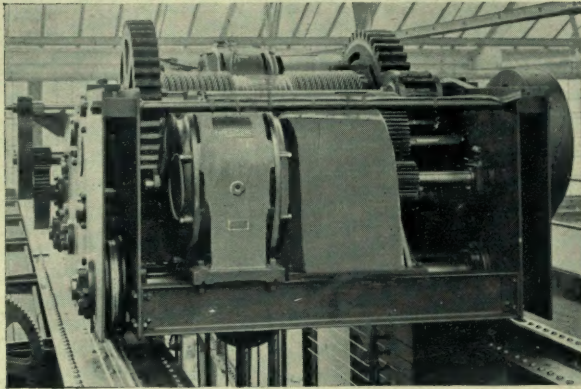
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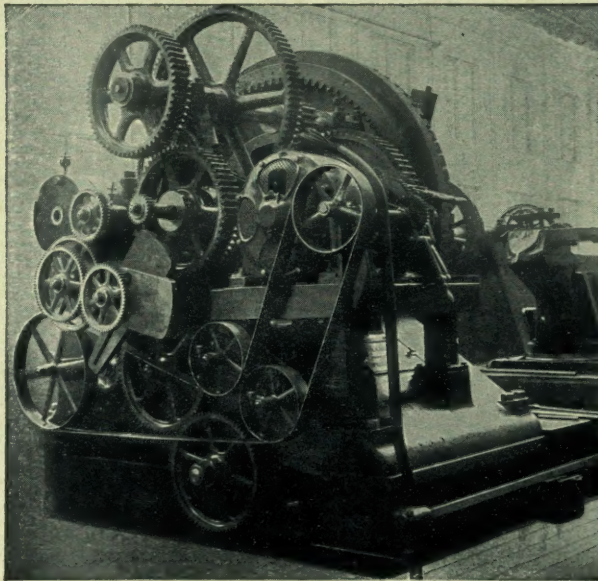
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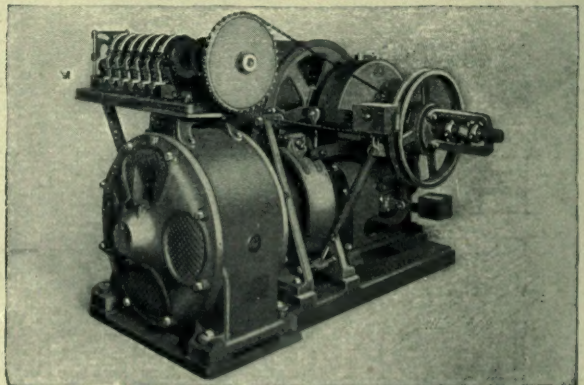
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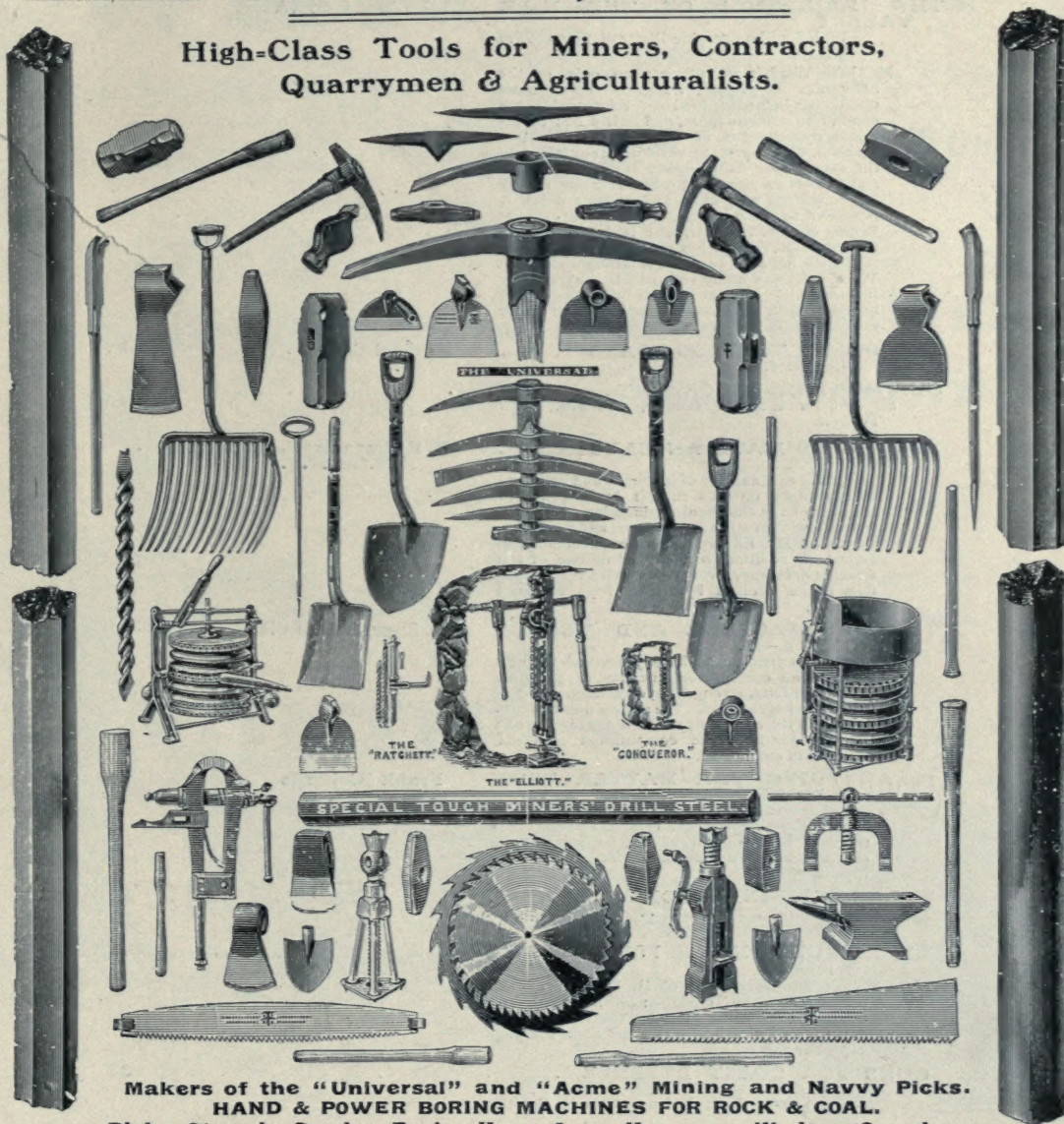
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No. I.

JANUARY, 1904.

Vol. IV.

THE ASSOUAN RESERVOIR.	Frontispiece
View at summit level, winter 1902-3, showing the submerged Temples of Philae, looking east.	

SPECIAL ARTICLES.

THE IRRIGATION OF THE NILE VALLEY	John Ward, F.S.A.	3
With Six Photographic Illustrations and Five Maps.		
Mr. John Ward is an authority not only on the antiquities of Egypt, but also upon those questions which make for the development of the country in modern times, and he has had exceptional opportunities of studying the irrigation problem. He shows the revolutionising effect of the dams which have already been constructed, and unfolds an important scheme for restoring to the Sudan the prosperity and prestige which it possessed in ancient times. A promising area for British engineering enterprise is here disclosed, and when the scheme has reached a more mature stage, we hope to be able to arrange with Mr. Ward, who has lately returned to Egypt, for a further article on the subject, which is largely bound up with the successful maintenance of our interests in the Nile Valley.		
NEW DIVING TORPEDO BOATS	Herbert C. Fyfe.	14
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HOW TO EDUCATE AN ELECTRICAL ENGINEER	E. Kilburn Scott, M.I.E.E., A.M.Inst.C.E.	17
In response to a number of inquiries, and believing that a paper on this subject by a practical member of the electrical engineering profession will be useful to students, parents, and guardians, we asked Mr. Kilburn Scott to undertake this article, in addition to a careful outline of the training necessary, which deals with various pitfalls to be avoided by the embryo electrical engineer.		
THE MANUFACTURE AND USE OF CONCRETE—II.	A. Legg, M.Inst.C.E.	22
The previous article was largely devoted to tests of Portland cement for fineness of grinding, specific gravity, strength, hydraulicity, speed of setting and soundness. The author now confines himself to the essentials of good aggregates and their preparation, the computation of voids, methods of mixing, &c.		
IS ANYTHING THE MATTER WITH PIECE WORK?	Frank Richards	25
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A 3-in. 12-pounder Landing Equipment by Messrs. Vickers, Sons, and Maxim.		
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With Nine Illustrations.		
The present article covers the various systems of winding in vogue. The previous article described the geology of the district, methods of working the coal, and means of transport. The series will be continued.		

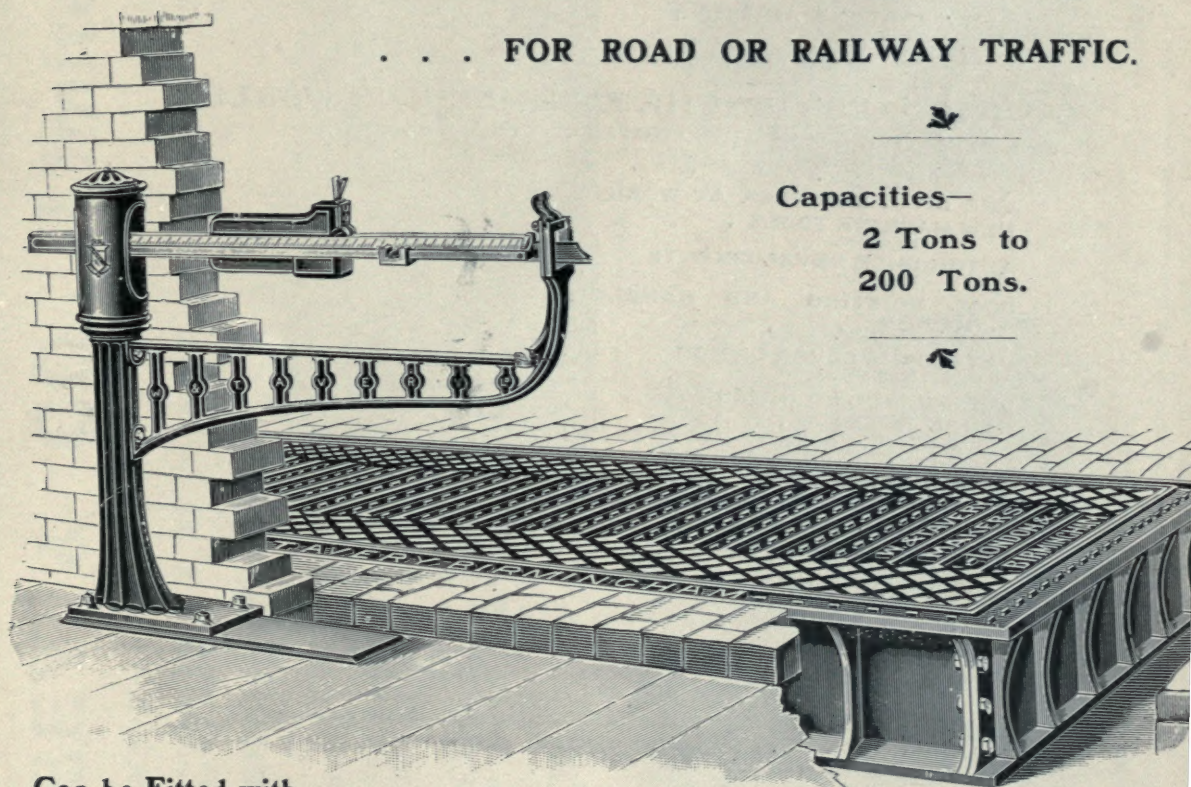
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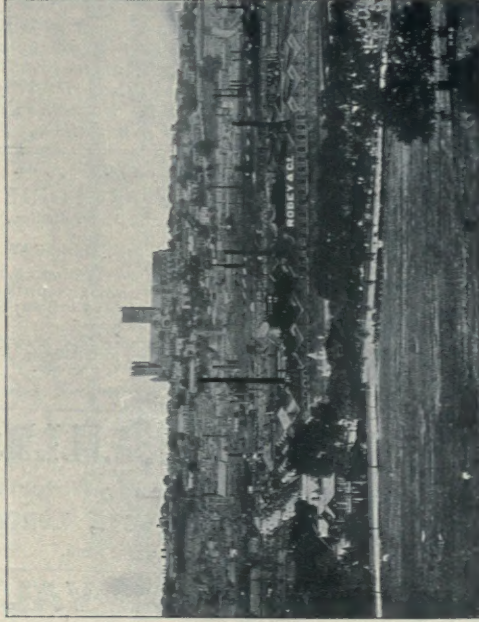
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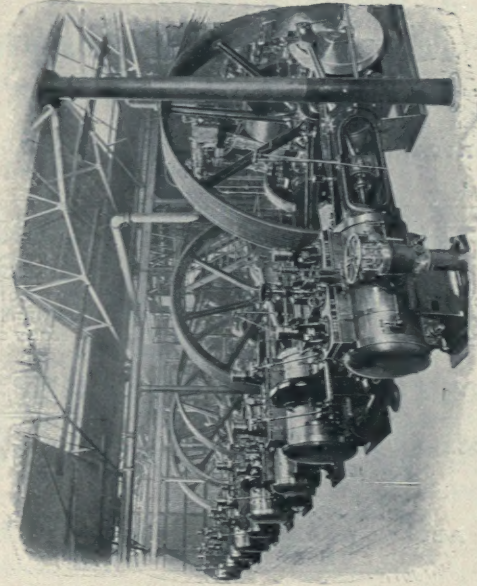
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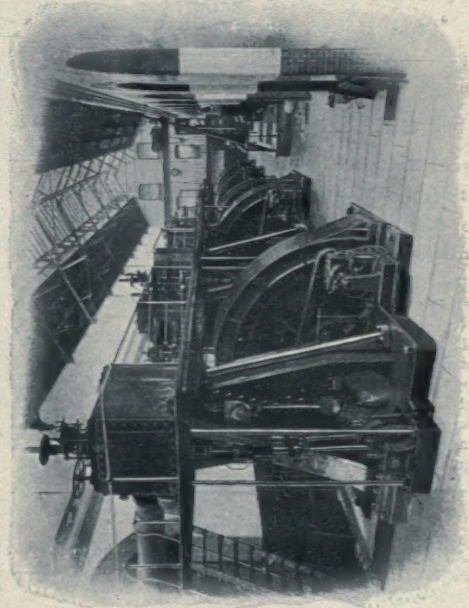
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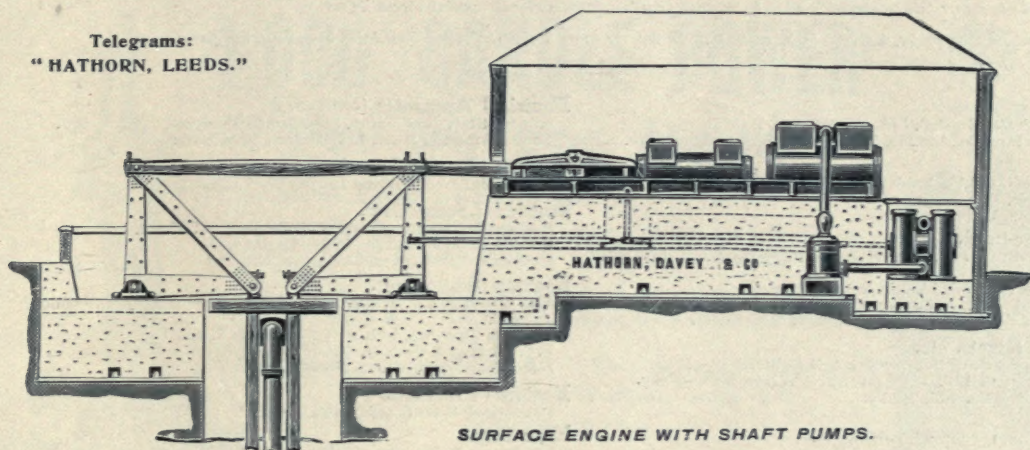
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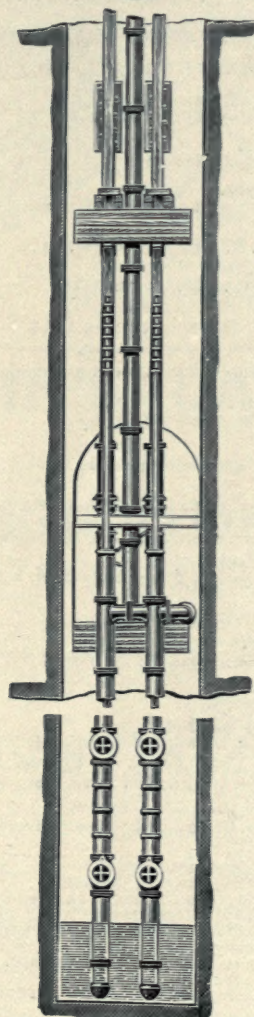
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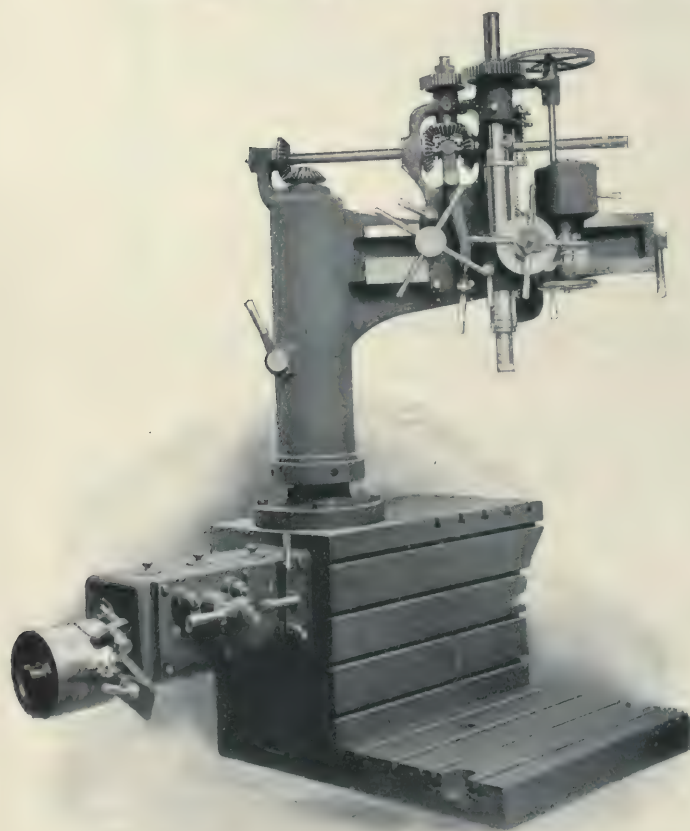
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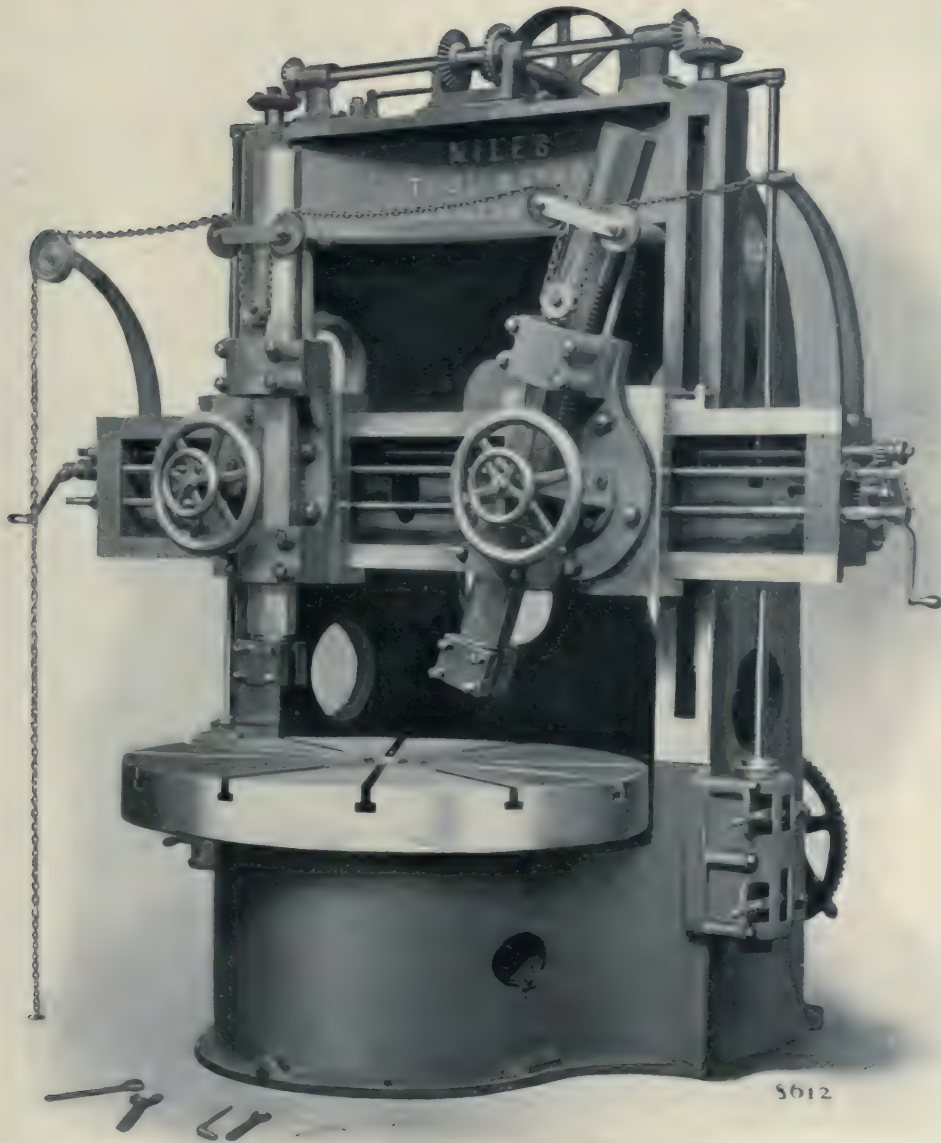
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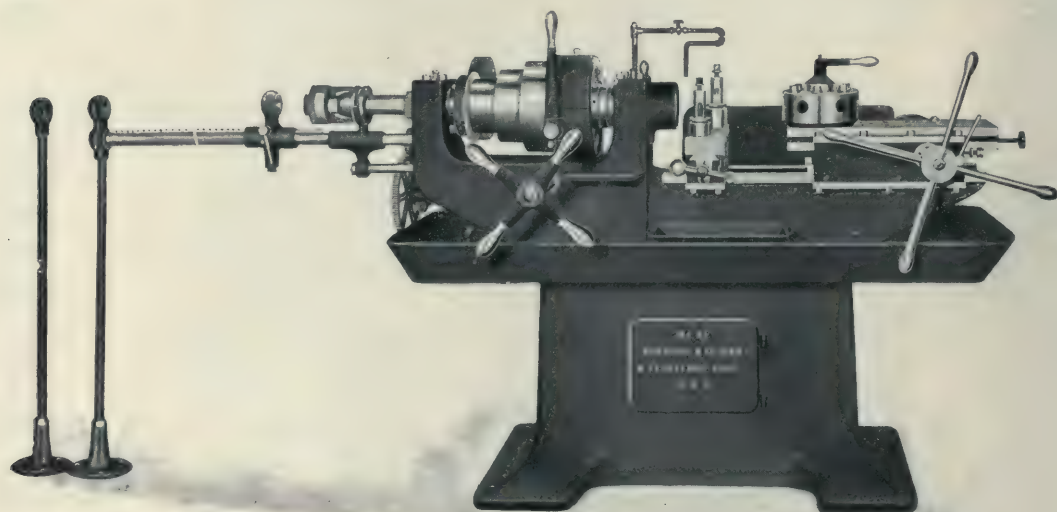
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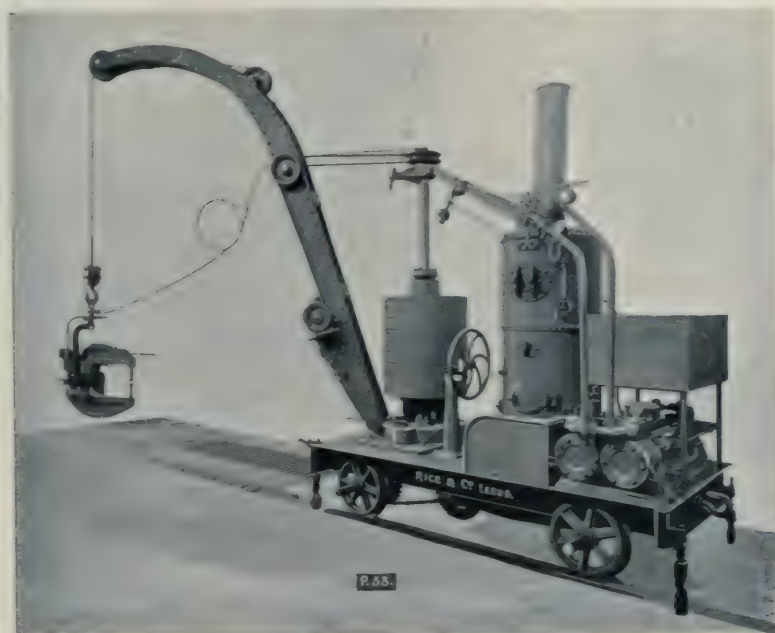
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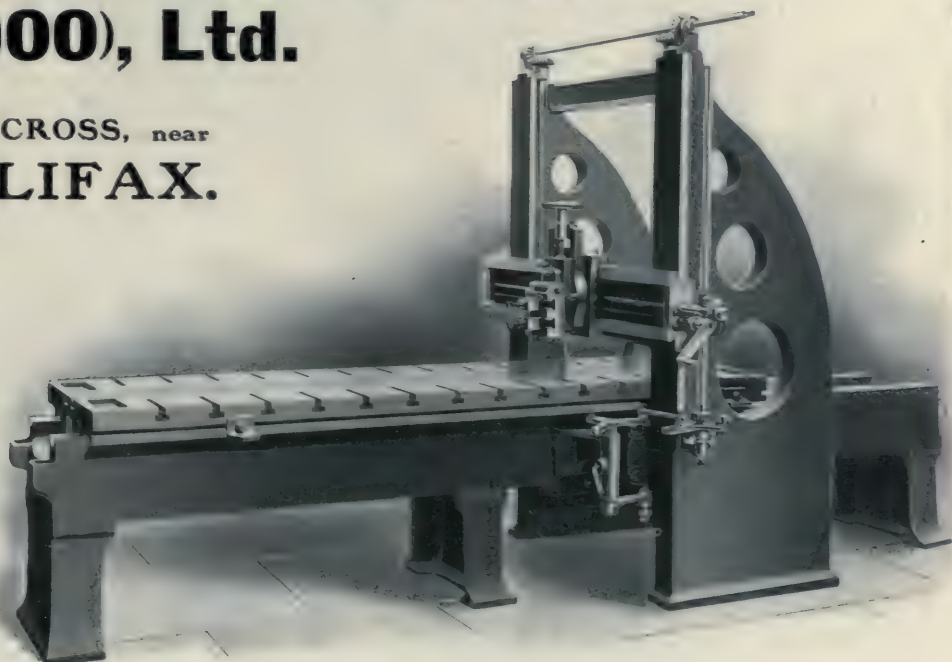
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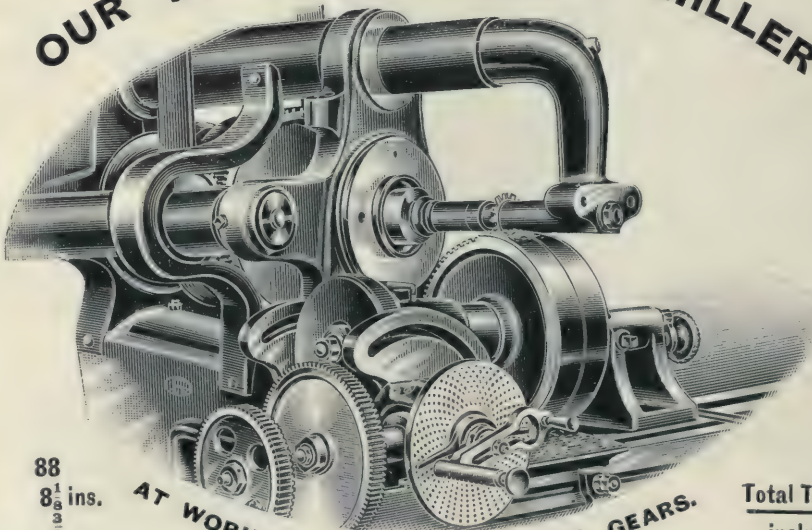
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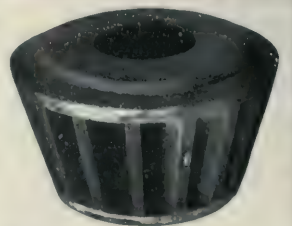


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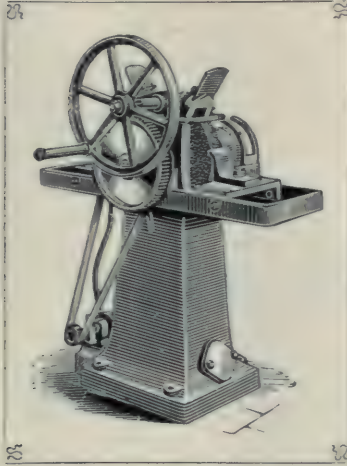


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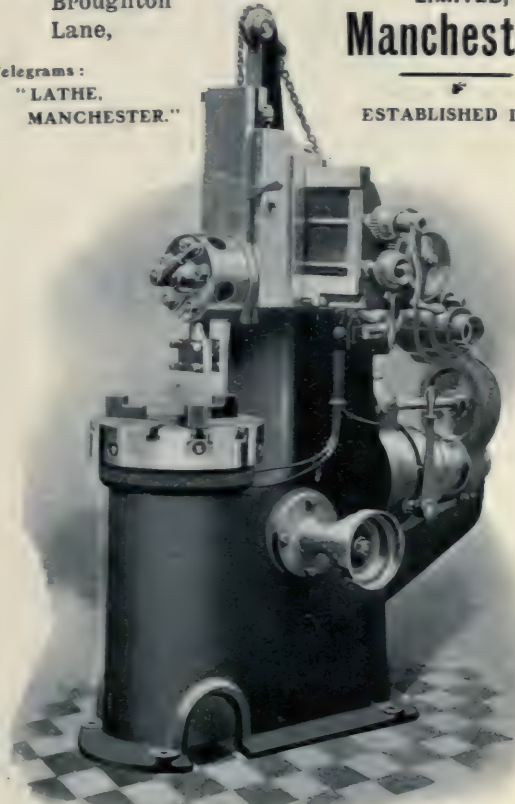
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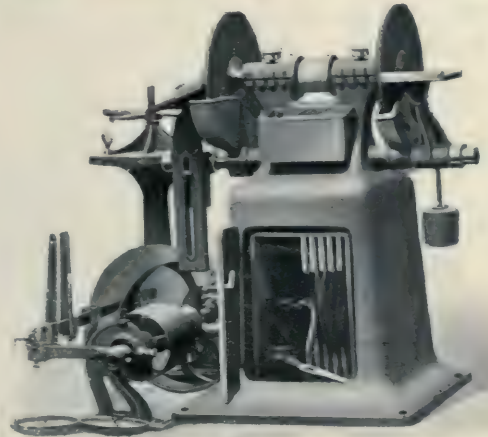
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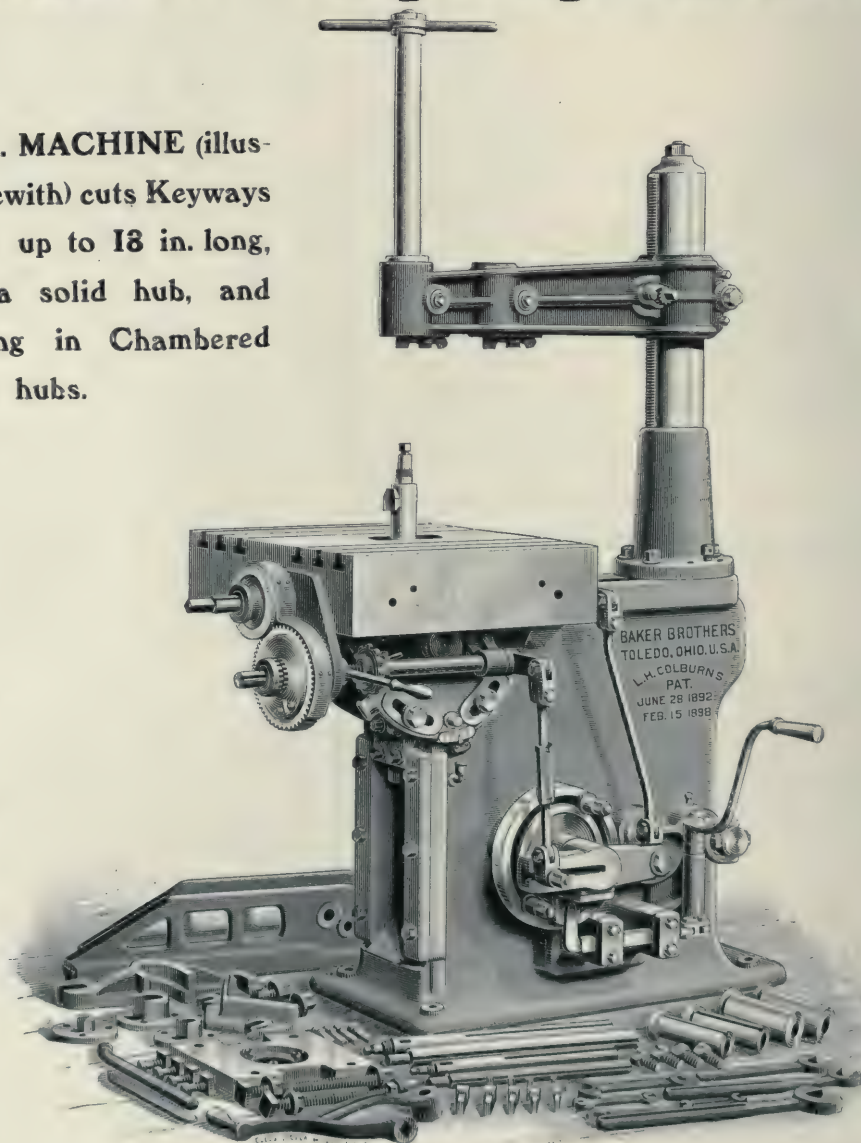
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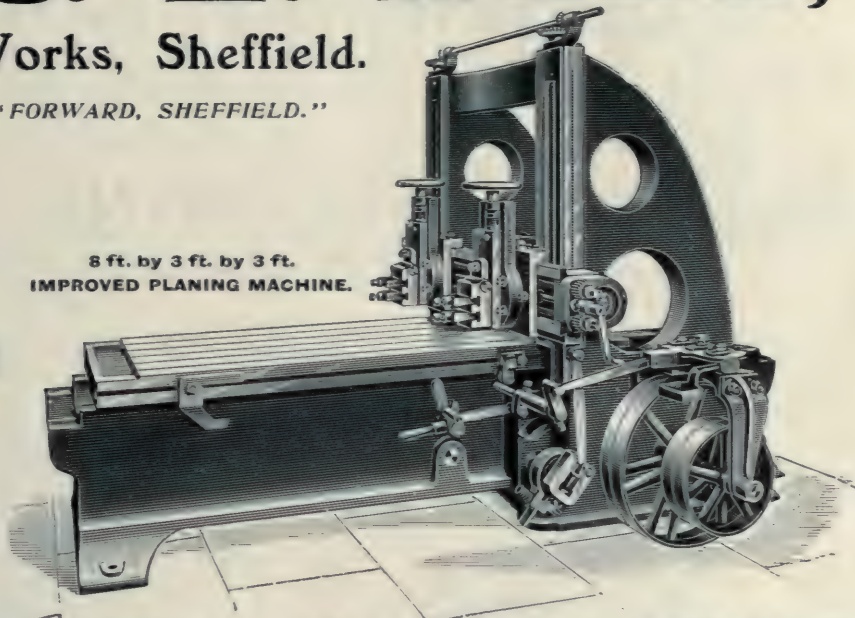
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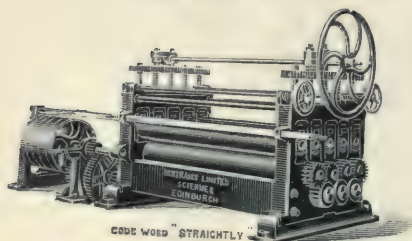
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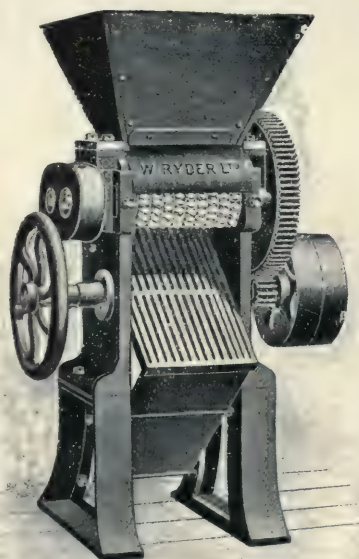
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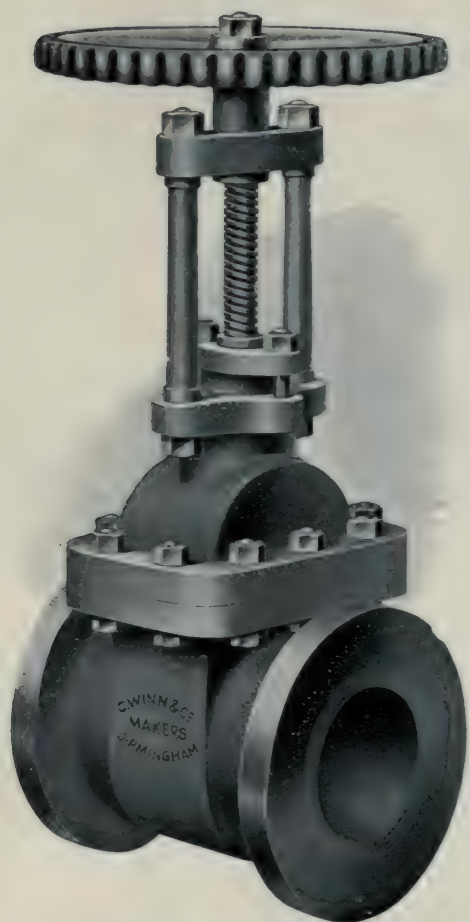
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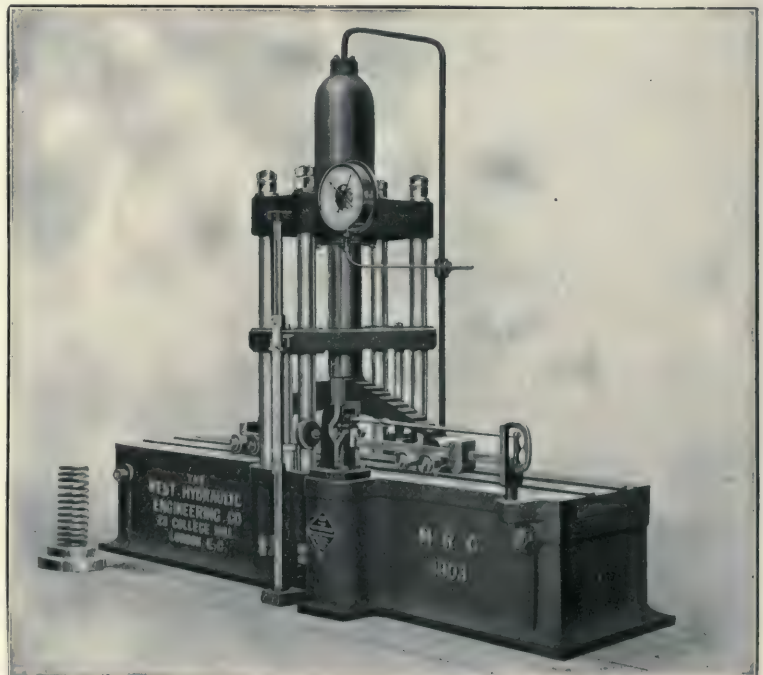
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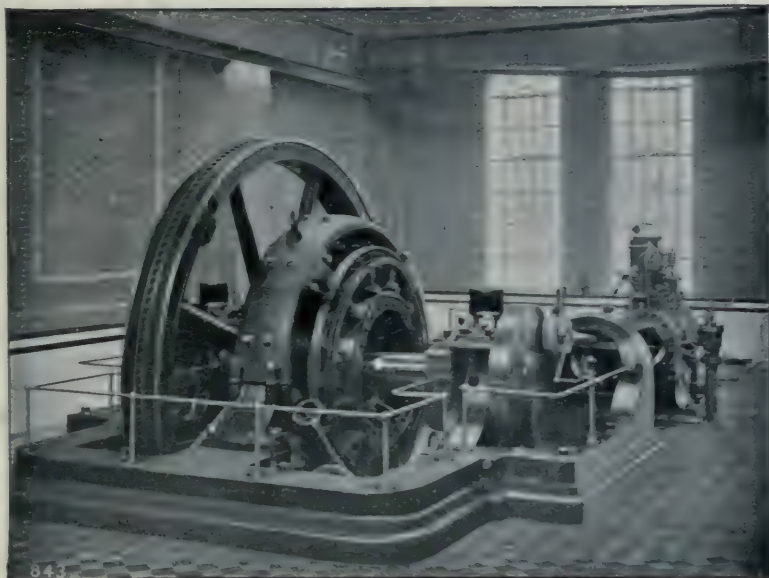


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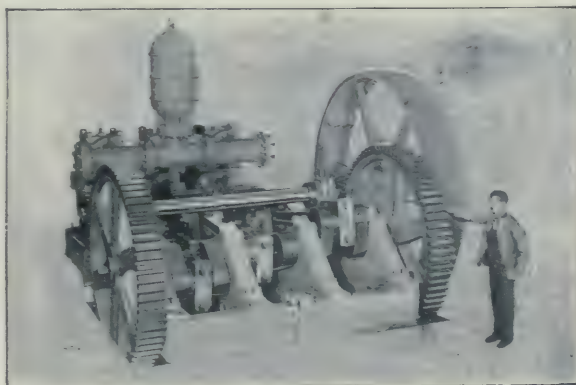
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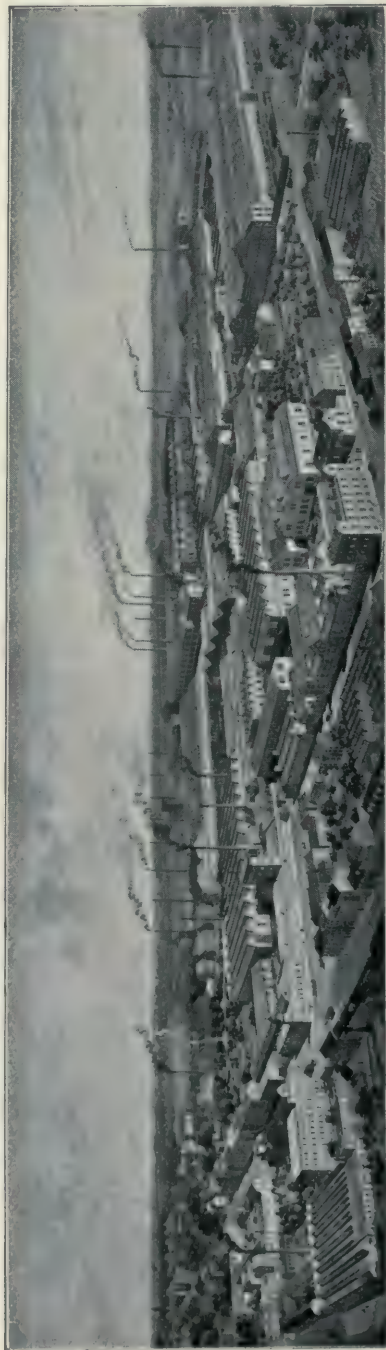


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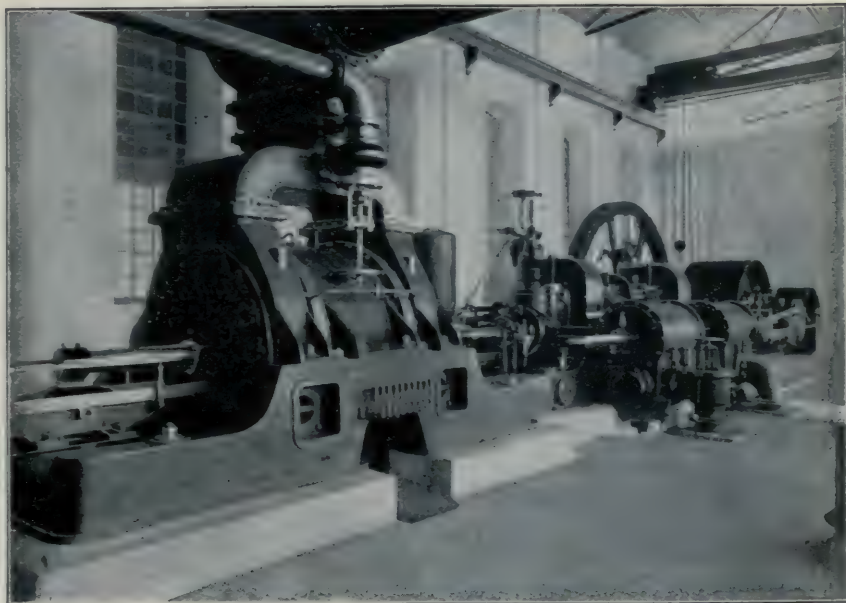
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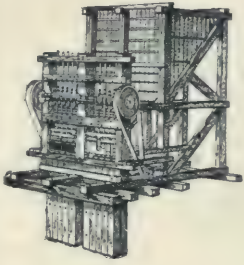
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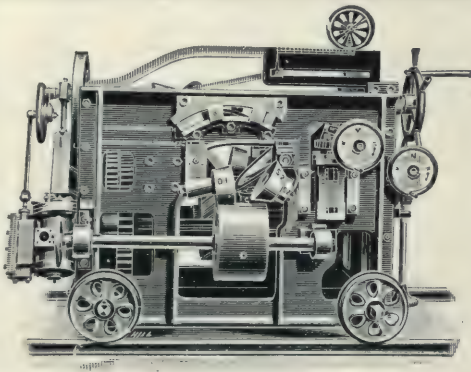
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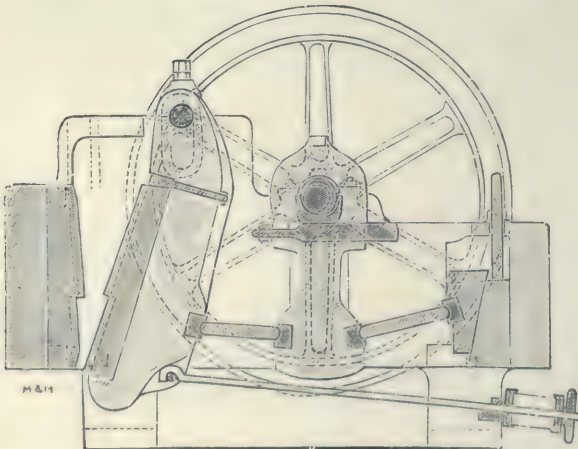
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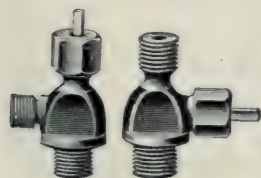
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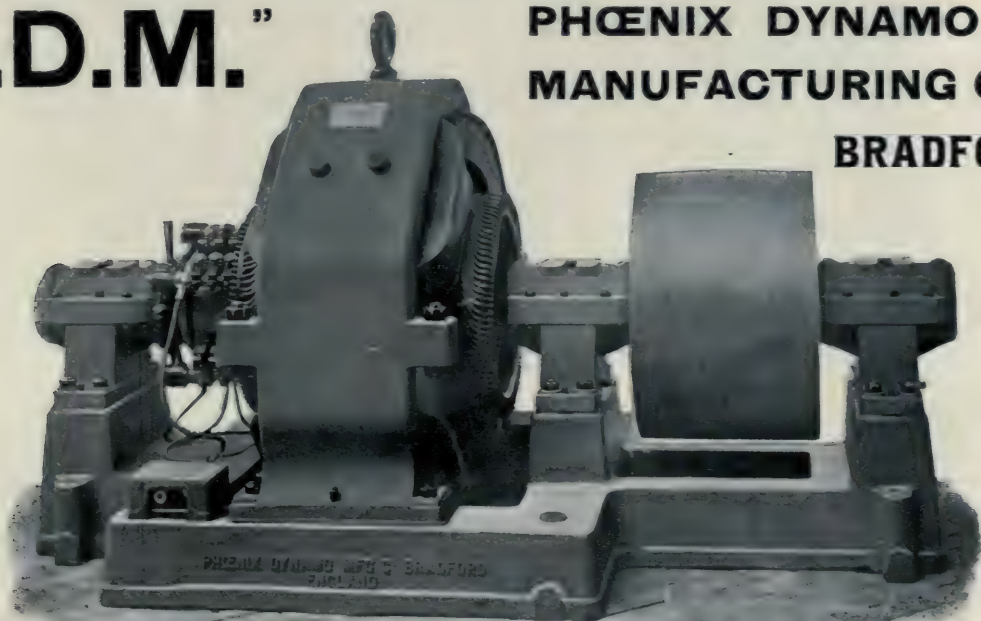
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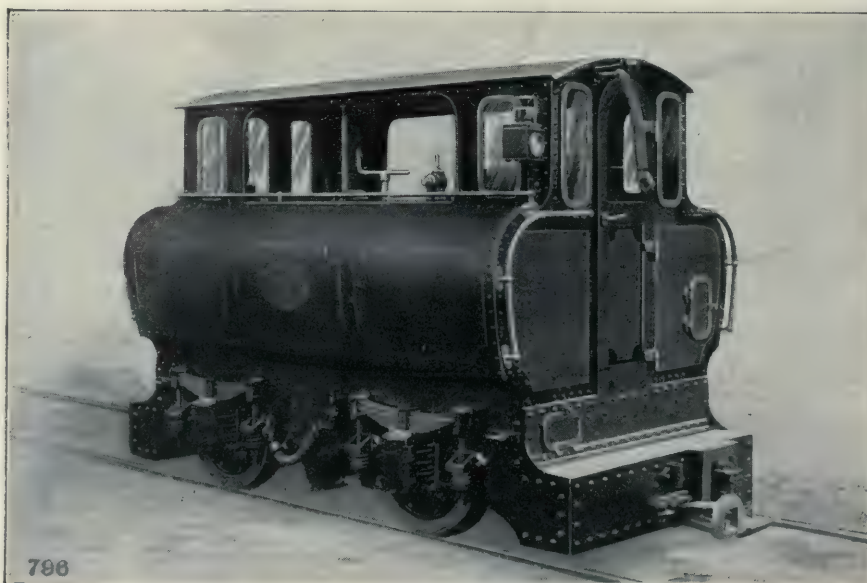


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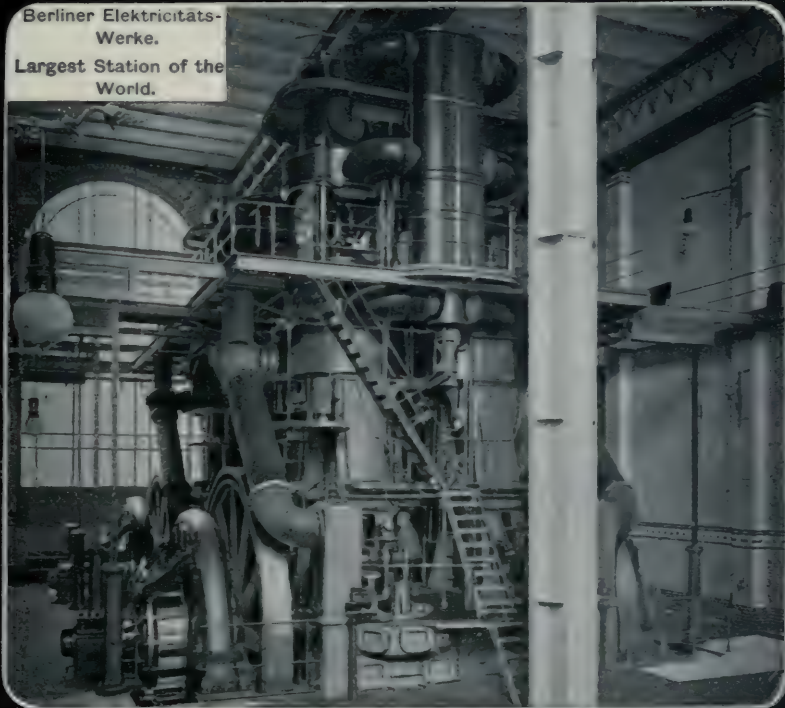
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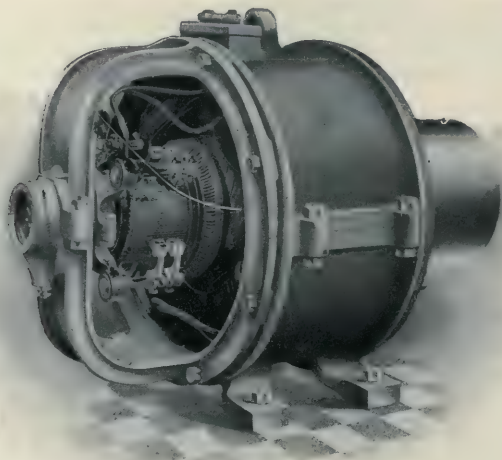
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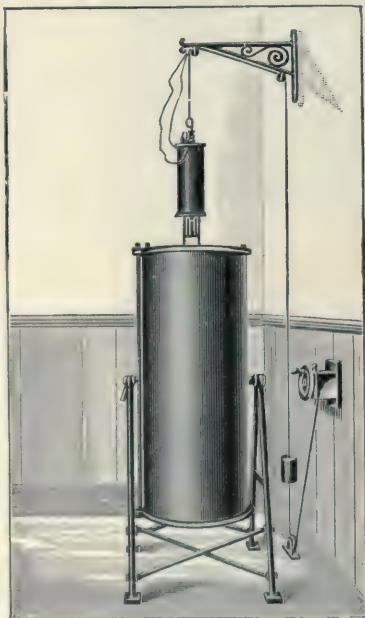
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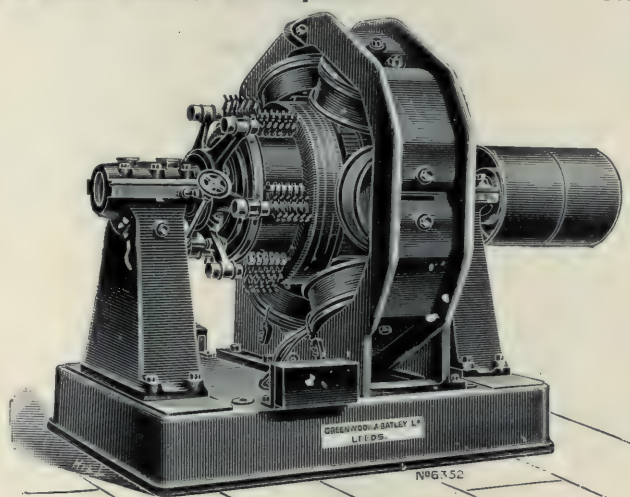
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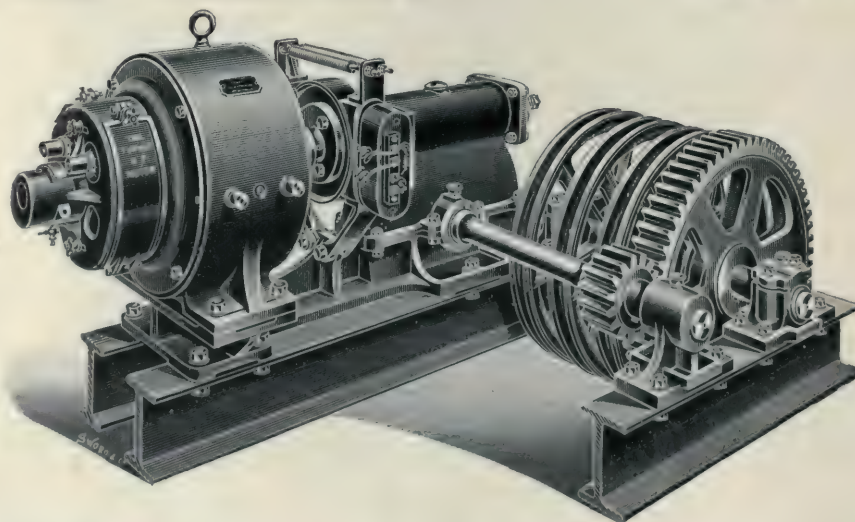
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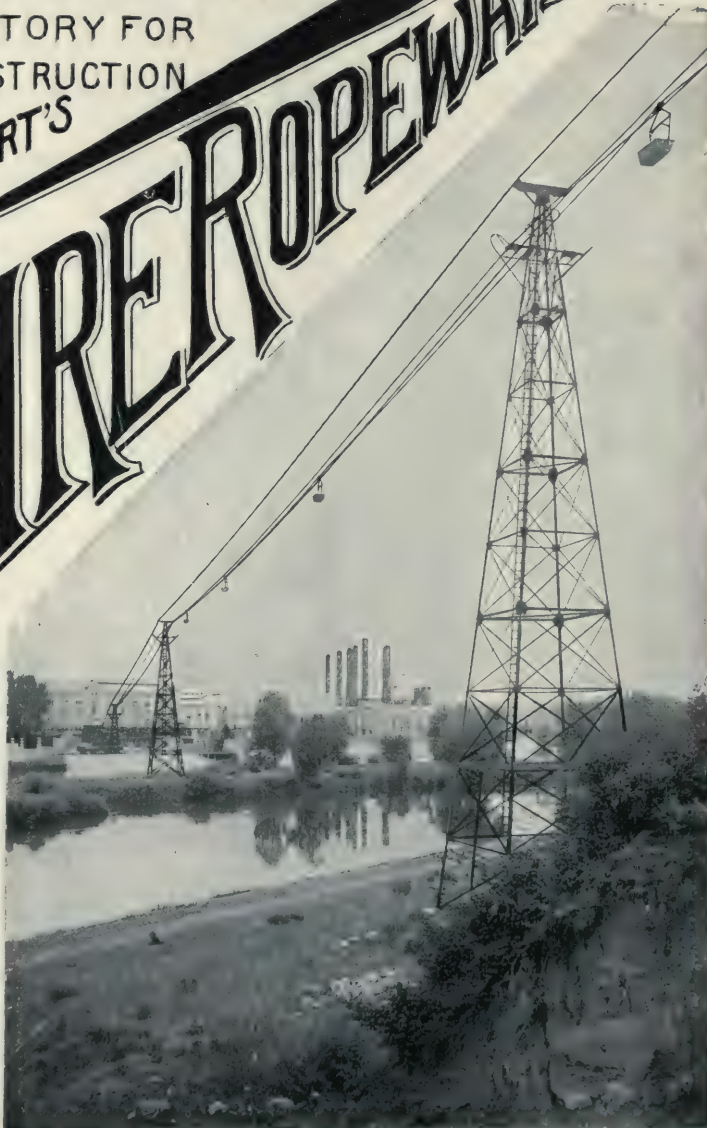
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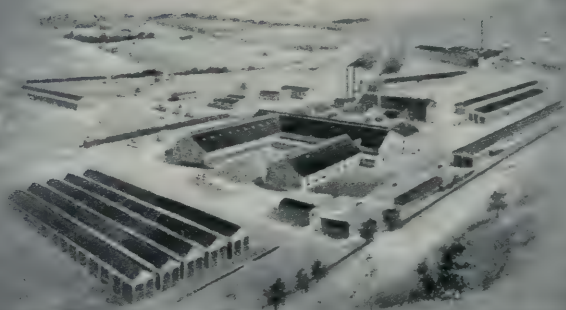
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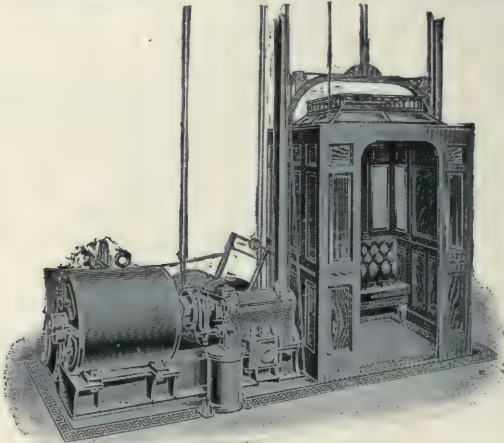
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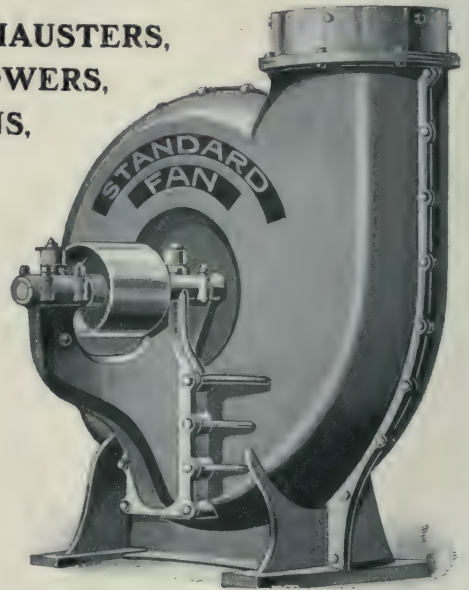
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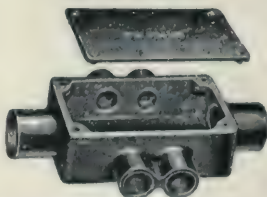
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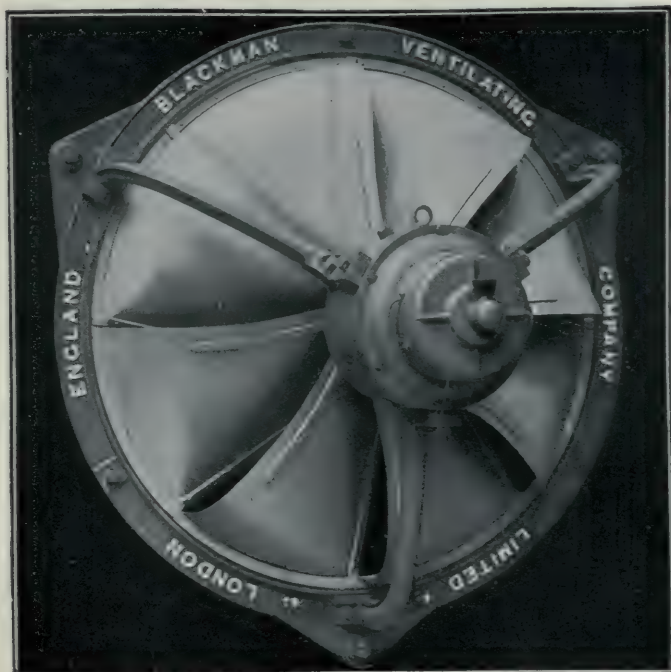
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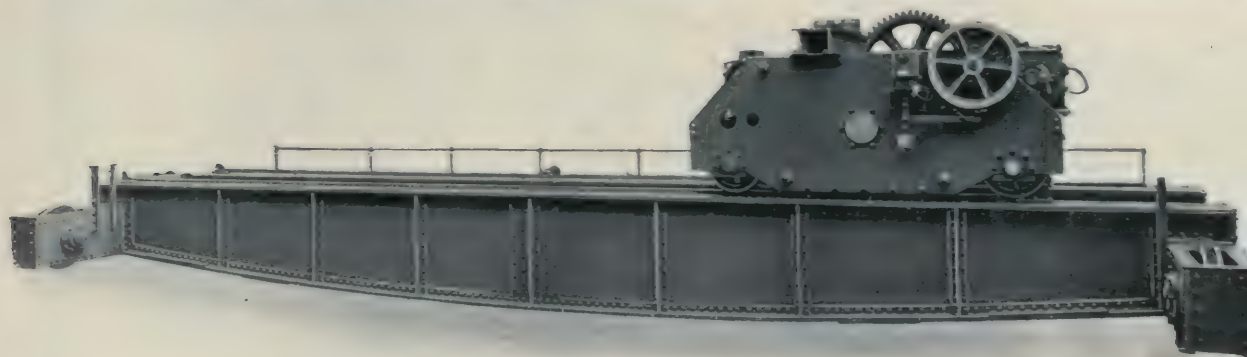
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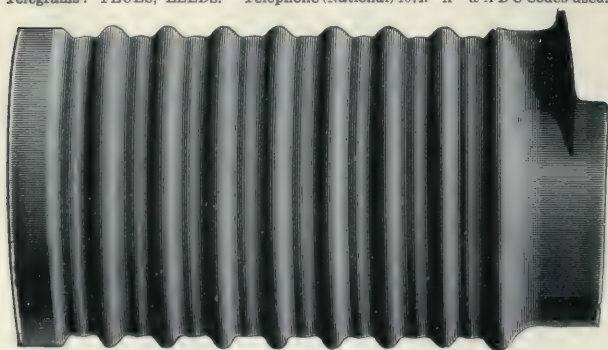
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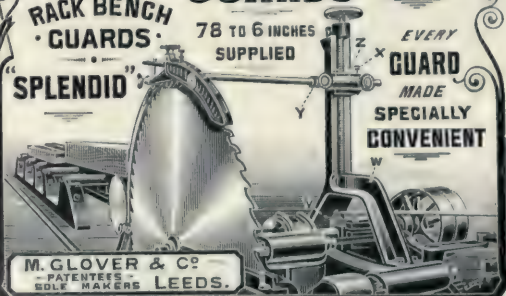
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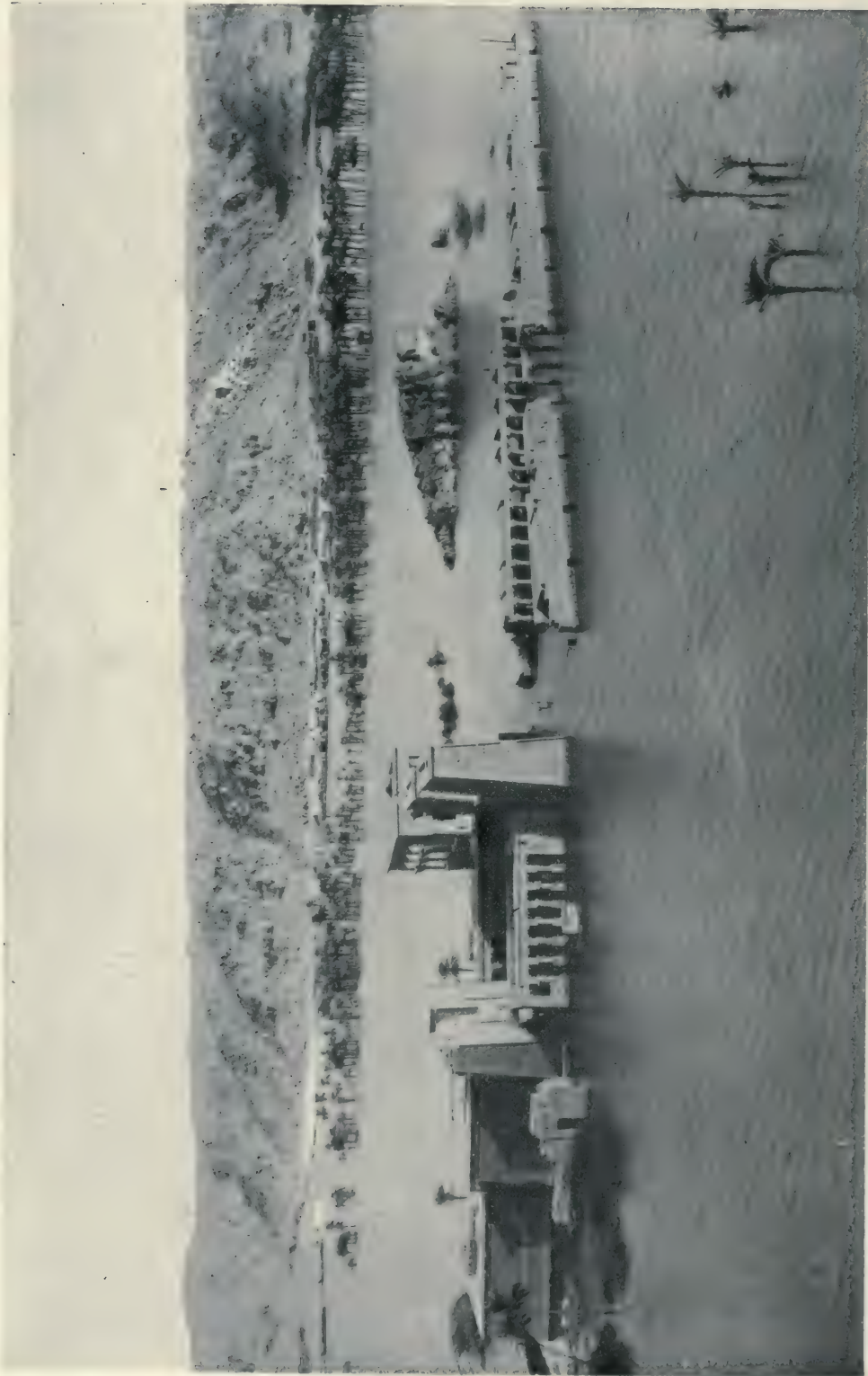
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Nectanebo's Temple.

THE ASSOUAN RESERVOIR—VIEW AT SUMMIT LEVEL, WINTER 1902-3, SHOWING THE SUBMERGED TEMPLES OF PHILAC, LOOKING EAST.

A short time before the Assouan Dam was opened and the region was flooded, the author dwelt for some time in a modest dwelling at a spot in the centre of the picture, which is now marked only by submerged palms. The hut, railway station, and the village of Shellal have all disappeared, the inhabitants removing to new quarters provided beyond the reach of the waters.

PAGE'S MAGAZINE

An Illustrated Technical Monthly, dealing with the Engineering, Electrical, Shipbuilding, Iron and Steel, Mining and Allied Industries.

VOL. IV.

LONDON, JANUARY, 1904.

No. 1.

THE IRRIGATION OF THE NILE VALLEY.

BY

JOHN WARD, F.S.A.

Mr. John Ward is an authority not only on the antiquities of Egypt, but also upon those questions which make for the development of the country in modern times, and he has had exceptional opportunities of studying the irrigation problem. He shows the revolutionising effect of the dams which have already been constructed, and unfolds an important scheme for restoring to the Sudan the prosperity and prestige which it possessed in ancient times. A promising area for British engineering enterprise is here disclosed, and when the scheme has reached a more mature stage we hope to be able to arrange with Mr. Ward, who has lately returned to Egypt, for a further article on a subject which is largely bound up with the successful maintenance of our interests in the Nile Valley.—Ed.



TWENTY years ago England found herself committed to the guardianship of Egypt. The empire founded by Mehemet Ali had been ruined by the reckless extravagance of Ismail. All other nations held aloof.

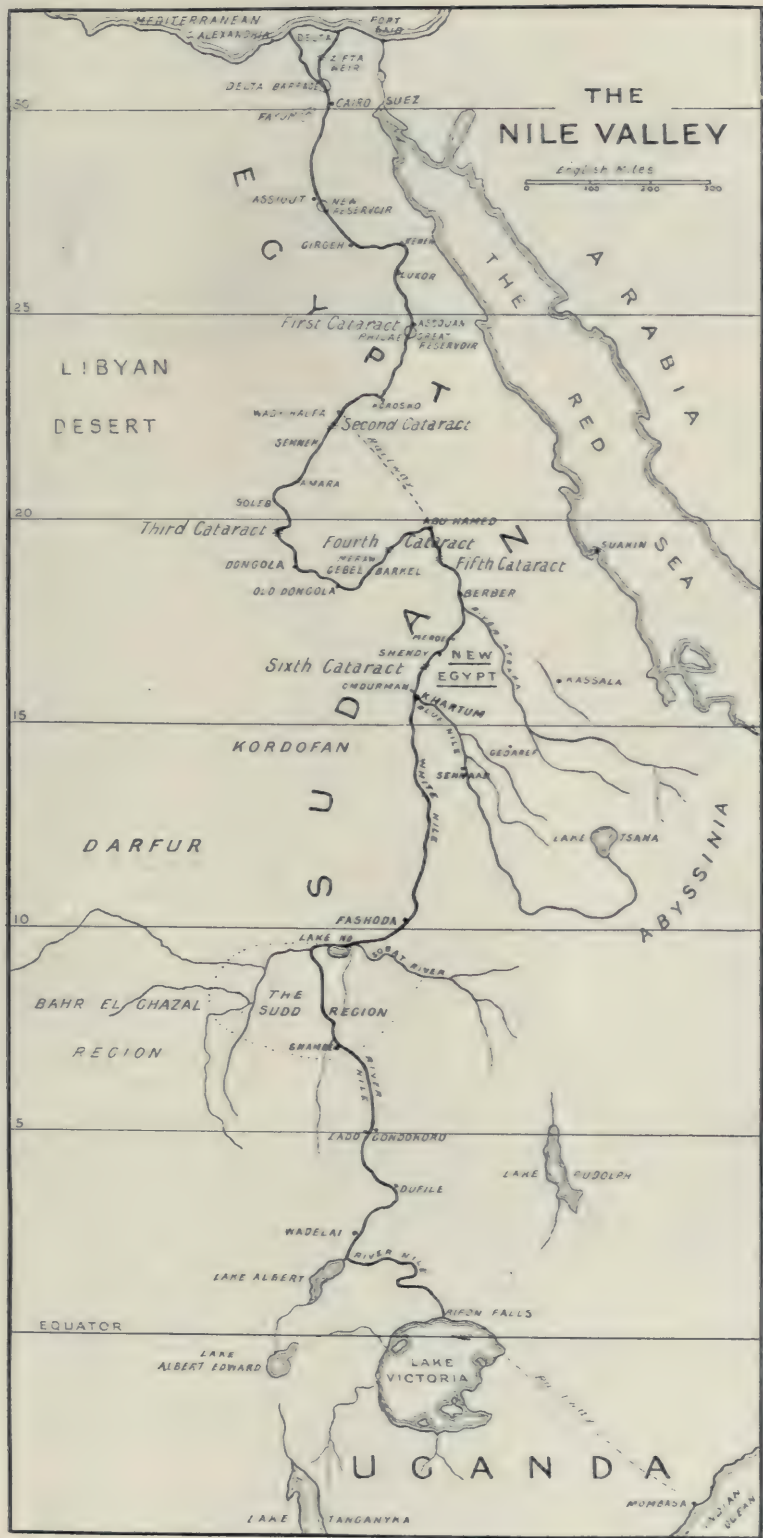
Egypt seemed to have no friends left, as every available asset was mortgaged, apparently beyond hope of redemption. The French fleet, sent to protect the country in its dire necessity, sailed away. Our fleet, sent on a similar errand, remained at Alexandria, and saved Egypt from revolution. We have remained its Protectors ever since. In 1882, Lord Dufferin, being our Ambassador at Constantinople, was asked to visit Egypt and report. His advice mainly consisted in these points: "Establish an honest financial system; create a new army under British officers' training; bring trained engineers from India to introduce the system of irrigation, which has been so successful there. The Nile, under proper management, will bring in a sufficient revenue to meet all requirements." All this was carried out. The "Blue Books" of the time show how arduous was the undertaking; the results prove the wisdom of the

advice. When the system of Perennial Irrigation is fully developed, two crops, and even three in some cases, will be possible. Forced labour is abolished, unless in cases of great emergency, such as the bursting of a canal bank. Water is the very life of Egypt. Formerly, the Pasha could divert all the irrigation to his own estates, if he pleased, and the fellah was taxed, whether he got the water or not. Now the peasant gets his supply equally with the Pasha, each in his regular turn.

All this is the work of the British engineer officers. The effect on the whole land is marvellous, the flocks and herds are doubled, the people are happy, better clad, are becoming rich, and are learning to use the savings banks, which have recently been established for their benefit. Schools are well attended, and all children, male and female, can now learn to read and write Arabic, and English if they so desire. Under all this it is no wonder that the returns of revenue are increasing by leaps and bounds.

Nobly have the small band of Britishers done their duty. Many have retired after active service; not a few died at their posts; these were replaced by men similarly trained. Sir William Garstin still leads the van of peaceful

The Irrigation of the Nile Valley.



generals, Sir Colin Scott Moncrieff, Sir W. Willcocks, and Sir Hanbury Brown have retired from the service, receiving their well-earned titles for their eminent services. The veteran Lord Cromer still guides the destinies of the land, the wisest and kindest of rulers.

THE NEW DAMS AND THEIR EFFECT.

The vast reservoirs for perennial irrigation recently completed, caused the expenditure in labour of several millions sterling, of which the greater part was spent among the natives of of the country. At one time 20,000 men were at work. The mere fact of the new Dam at Assiout being completed a year before the contract time was the means of saving the whole cotton crop of Lower Egypt, valued at several millions sterling. The Nile "had forgotten to rise" in 1902, and had such a calamity occurred before the rule of the British Engineer, a famine would undoubtedly have resulted, with a loss of many thousand lives. Seed was supplied by the Government and all taxes remitted to those who suffered by the scarcity of water.

The income of the Egyptian Exchequer being assured, the enormous debt of the country, exceeding £100,000,000, is being gradually reduced, and its interest regularly paid as a matter of course.

FURTHER OPENINGS FOR BRITISH ENGINEERS.

In 1905 the debt is to be settled on a basis of sinking fund, which, it is expected, will *extinguish Egypt's entire debt* in fifty years. About the same time, the whole



FIG. 3. ZIFTA WEIR—RAYYAH ABBAS HEAD WORKS WITH CANAL LOCK.

One of the main features that the engineers had to keep in mind in constructing this barrage, was not only the irrigation of the land adjoining the Nile, but also the maintenance of an unobstructed waterway throughout the delta. At the extreme right may be seen a lock, through which vessels of considerable draught can pass all the year round.

revenue of the Suez Canal will fall absolutely into the hands of the Egyptian Government. This will be between three and four millions sterling per annum. Should Egypt require capital for the irrigation of the newly acquired Sudan Province, there can be no doubt that it has ample security for anything it may need, and, since the Sudan belongs jointly to the British Empire, the loan can probably be obtained at the same rate as if Great Britain were the borrower. Before perennial irrigation can be fully given to Egypt, further canals, weirs, and other engineering works in many parts of the country will be necessary. These, however, will all be within the powers and means of the ordinary staff of the Irrigation Department. Sir Hanbury Brown, late Chief of Irrigation of Lower Egypt, before his retirement from the service a few months ago, saw the completion of a very important undertaking, planned by himself, and entirely carried out by the ordinary staff. This is the greatest work ever so executed, and is of sufficient importance to be pictorially illustrated.

THE ZIFTA BARRAGE.

In order to assist in the distribution of water in the northern portions of the Delta, it was found necessary to construct a weir at Zifta, a point on the Damietta branch of the Nile, about half way between the Cairo Barrage and the sea. In the future the main canals which supply the Southern tracts of the Deltaic provinces will, as at present, obtain their supply of water from the river, upstream of the existing barrage, but the areas lying to the north will be supplied directly from the new Zifta weir. The advantages of this arrangement are obvious. The length of the existing canals is very great, and

they traverse large tracts of highly cultivated country. It has been very difficult to force the water down to their northern reaches in sufficient quantity to give the lands dependent upon them their fair chance of water. With the completion of the new weir, or barrage, the lengths of the supply canals will be much reduced, and the distribution of water to the northern tracts will be greatly facilitated.

The Zifta Barrage was commenced in 1901. The total estimated cost of the work was £450,000, which includes a lock for navigation. It has actually been built for £320,000. The design is practically identical with the plan of the Assiout Barrage. The foundations at Zifta, as at Assiout, consist of a thick bed of concrete enclosed between cast iron "sheet piling." The weir consists of 50 openings of 5 metres each, with a lock of 13 metres in width. The total length of weir from bank to bank is 373 metres. It is planned to hold up 4 metres of water. (In summer water level upstream R.L. 7.30, downstream, 3.30.) The gates were, however made higher than originally designed, so that as much as 8 metres could be held up in case of a good supply, and in the summer of 1903 this was actually done. The soil of the river bed upon which the foundations were laid turned out to be far better than was expected, and this facilitated the work greatly. Great credit is given to Mr. Frederick Hurley, the resident engineer of the work, Sir W. Garstin, in his report, remarking that had it not been for his excellent arrangements, such a good out-turn of work would have been impossible.*

* Mr. Hurley is a native of Belfast. He was educated at Cooper's Hill College, and has been six years in Egypt.

The increased water supply, owing to this work, will repay the entire cost in a short time, in extending the area of cultivable land, as the taxes are levied on the crops actually produced.

The Great Reservoirs formed by the barrages at Assiout and Zifta have already had their powers tested in a remarkable manner. The Nile, from causes not yet fully understood, has often failed to rise to its ordinary summer flood. From the Bible record we find that the Low Niles of the days of the Patriarch Joseph lasted for seven years. Egypt has just recovered from four years of poor Niles, and in 1902 the river did not rise at all; it was the lowest Nile on record. The natives began to say "that 'Old Hapi' was so angry at the works of the British engineers that he would never rise again, and there would be no water to fill their dams." The dams, however, stored up so much of the ordinary Nile water that they saved the crops, though they were smaller, especially in districts remote from the river. Fortunately, the tide has turned, and the year 1903 witnessed a magnificent Nile flood. The great dams have thus shown their value during the lowest Nile on record, and that they are fully capable of dealing with normal risings.

THE WORK OF THE DAM AT ASSOUAN RECORDED PICTORIALY.

In this respect it will be interesting to record pictorially the aspect of the Great Dam at Assouan, in the winter of 1902-3, the first

occasion of its being filled to summit level. This was after the memorable summer, when the Nile did not rise at all; and yet the reservoir is full—too full for the unfortunate Island of Philæ. The photographs show it entirely under water, and only its temples, colonnades, and pylons peer above the deluge. The ancient Nilometer is swallowed up; the waters are high above the floor of Nectanebo's temple. The Kiosque (built for a proposed visit of Augustus that was never realised) still shows its unrivalled elegance of design—Egyptian architecture enriched by classic taste.

SELECTION OF THE ASSOUAN SITE.

The stored-up water, at a time when the Nile flow had been lower than ever recorded, is a triumph of engineering skill. But the illustrations may have a depressing effect on the mind, and an artist or archæologist may regret that Sir William Willcocks did not put the Dam a few miles further south. He, engineer-like, honestly chose the place best suited for his granite wall, where half of it was already made of the living granite rock. But when the Assiout Dam was built (on the river's bottom, actually on the Nile mud), was a granite foundation so necessary here? Well, we need not complain now; it is too late.

Sir Benjamin Baker also selected the same place, after Sir W. Willcocks had left the Government service. Sir B. Baker offered to re-erect every building, every stone of the temples on the adjacent Island of Biggeh (from which our



Ptolemaic Temple.

Pharaoh's Bed.

FIG. 5. THE ASSOUAN RESERVOIR—VIEW AT SUMMIT LEVEL, WINTER OF 1902-3.
Showing the general view of the submerged Island, looking south.



ZIFTA BARRAGE—RAYYAH ABBAS HEAD FROM

This Barrage, entirely constructed by the Egyptian Irrigation Department, with native labour, has not been previously

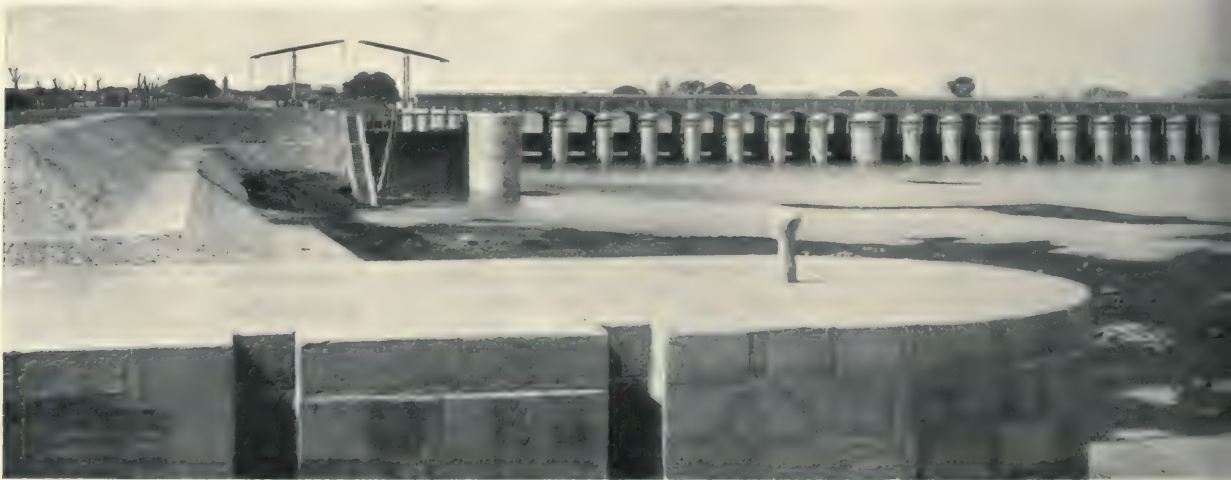
views are taken), but his offer was treated with derision by antiquaries.

It is only fair to Sir William Willcocks to state that he suggested various other sites for his dams as well as this one, and that he was not in the employment of the Irrigation Department when the work was decided on. The entire scheme for reservoirs which Willcocks had been employed to design, had been laid aside, and, thinking that he was no longer needed, he accepted other employment. Unexpectedly, Sir Ernest Cassel came forward with the funds, and Sir John Aird offered to make the dams. These offers were accepted, and it thus happened that other hands than the inventor's carried out the work. The author has his own private

opinion of the merits and demerits of the case, but at present he is relating only the story of the great works of the irrigation engineers, and it is better to keep to the utilitarian side of the question, and from that point of view alone, everyone must admit that it is the greatest construction of the kind that the world ever saw, and that it admirably performs its work.

INCIDENTAL SACRIFICES.

It is to be feared that when a few seasons pass, all the palm-trees, of which we now see only the tops in the photographs, will have perished. There was one shady plantation of fertile date-palms on the right bank of the old Nile, whose tops are now only seen above



ZIFTA BARRAGE—VIEW FROM RAYYAH

The Irrigation of the Nile Valley.

9



EAST BANK OF THE NILE, LOOKING UP STREAM.

illustrated. It is the greatest work of the kind yet undertaken and carried out, within the resources of the Department.

the waters. A few years ago these palms sheltered a tiny cottage, in which the writer lived for many weeks, employing his days in studying and recording with pen and pencil the beauties of the island and its interesting monuments, knowing that their fate was sealed. The cottage, with its pretty garden, is now overwhelmed. The most picturesque district in Egypt was doomed to disappear before the all-powerful engineer.

The beautiful island and its surroundings, however, have perished in a good cause! It is to be feared that some of the ancient temples on the Nile bank between Philæ and Wady Halfa will also be submerged by the waters of the great Dam. The narrow strip of culti-

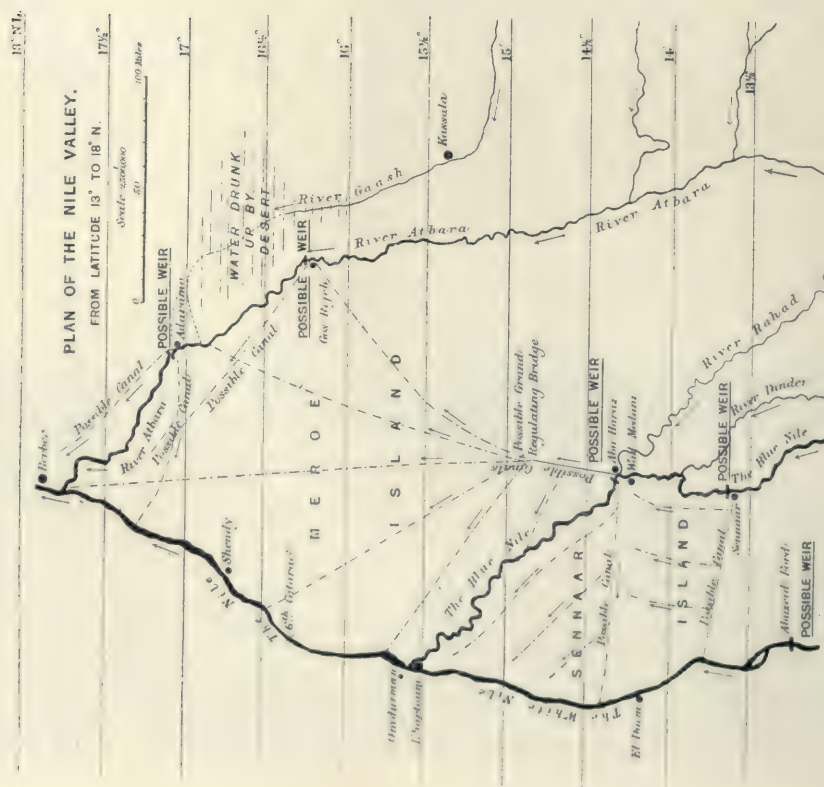
vable land along the Nile in Nubia will have disappeared in many places. Compensation, however, has been given, or good land elsewhere, allotted to the inhabitants by the Government.

THE DAIRA SANIEH ADMINISTRATION.

In Ismail's time and previously, much of the best land at many points between Cairo and Assouan had been forcibly seized by the State and converted into sugar and other estates. The unfortunate people who had owned the land for generations were driven off without compensation, themselves and their families ruined. On these great estates—known as the Daira Sanieh—comprising the best land in Egypt—Ismail had borrowed many millions sterling.



ABBAS HEAD, LOOKING DOWN STREAM.



SIR WILLIAM WILLCOCKS'S SUGGESTIONS FOR IRRIGATING HIS "NEW EGYPT."

As the present Government of Egypt undertook the liability of the payment of the interest, these lands became an asset which they could dispose of as seemed best for the interests of Egypt. In 1898 Lord Cromer concluded an arrangement with a group of financiers for the sale of all the properties, known as the Daira Sanieh Administration, for a price amounting to the sum of the Daira Sanieh Loan. The purchasing company undertook to re-sell the property under certain conditions in a certain number of years, the half of the profits to belong to the Government. This vast, unwieldy property is now successfully worked by private individuals, and will bring in a large gain to the Egyptian Government, much more than could have been obtained by official management.

EGYPT FIFTY YEARS HENCE.

Sir William Willcocks has been for some years manager of these vast estates. But he has not given up his deep interest in his own profession of an irrigation engineer, and frequently writes and lectures on the subject. One of his most remarkable lectures—"Egypt Fifty Years Hence"—was recently given in Cairo. In this lecture, which has been printed for private circulation, he enlarges on the results of the completion of the system of perennial irrigation, and describes the development of canals, weirs, escapes, and pumps, that will gradually bring the area of cultivated land up to what it was in the days of the Romans, when vast spaces, now desert and barren, were under cultivation. Egypt was then the granary of Rome, besides supporting double its present population. In far earlier ages Egypt must have been densely peopled. All over the country one finds immense black mounds of rubbish, the sites of lost cities deserted 3,000 years ago. Many of these are in the now barren desert. Sir William Willcocks would give them water again, restore the country's fertility, and by spreading the black rubbish over the land by means of light railways, would fertilise it. Strange to say, the rubbish heaps make the best of manure, being nearly all composed of old decayed mud bricks, mixed with organic matter.

PROPOSED IRRIGATION OF THE SUDAN.

But the most interesting portion of Sir William Willcocks's address referred to his suggestions for the proposed irrigation of the Sudan. He explains that the circumstances of the Sudan are quite different from those of Egypt. The Nile in the new provinces flows in a deep trough, and does not overflow its banks as in

the North. The system of irrigation must be quite different from that of Egypt, and more like the plan pursued in India.

In Egypt the Nile has no tributary streams, and the land is rainless. In the Sudan there are two considerable rivers falling into the Nile, which rise in the Abyssinian mountains, and there is a rainy season in the neighbourhood of Khartoum and beyond. From Assouan to Khartoum the Nile traverses pure deserts in a clearly defined channel of 1,150 miles without any loss beyond that of evaporation.* Willcocks says that that Nile is fed by percolations from springs along its course, and that the losses by evaporation in summer are fully met by these springs.

The mean discharge of the river in Nubia is 100,000 cubic feet per second—the maximum being 475,000 cubic feet, and the minimum 7,000 cubic feet, per second. It is this great margin of wasted flood that suggested the formation of the New Nile Reservoirs.

There are ruins of great cities all along the river banks, from the Second Cataract to Abu Hamed. The district is now almost deserted, save for the poor towns of Dongola and Merawi and some wretched villages. In ancient times this region supported an enormous population under powerful kings, and gave a dynasty to Egypt. It is now deserted and barren, but irrigation can restore its fertility. The Third and Fourth Cataracts can be exploited to provide supplies by the erection of weirs, and locks for navigation would form a part of them. Beyond Abu Hamed the Fifth Cataract could be similarly made use of, and irrigation supplied all the year round. At Berber we approach the rainy district, and hence will be in a couple of years the railway communication with Suakin and the Red Sea, now in progress, from which Lord Cromer expects so much.

THE NEW EGYPT.

We now enter the ancient Kingdom of Meroe—a populous region down to Roman times. There are vast ruins of cities, pyramids, and temples. The irrigation canals and reservoirs which gave them life can still be traced. The mountain streams were once dammed up in the rainy season, and all the land was richly cultivated. Now it is a wilderness, deserted save by wild animals, though there are still a few villages, and partial cultivation is in progress. The Atbara pours into the Nile here, the first

* At the Second Cataract, however, there seems to be a wide expanse of waste, which could be easily converted into a reservoir by a weir, and would undoubtedly be of great service to Nubia.

contributory river to "Old Hapi," who has to pursue his unaided rainless course all the way to the Mediterranean.

Between the Atbara and Khartoum the land was known in classic times as the Isle of Meroe. No doubt in those days it was richly cultivated, and teemed with population, flocks, and herds. Now it is depopulated save by gazelle, deer, and other game. The country is covered with mimosas, stunted trees, and prickly shrubs. Poisonous "apples of Sodom" and many wild flowers flourish. All this growth is fed by the copious rains of autumn, and were the waters stored up for irrigation as in olden days, there would be good crops, given the population necessary to cultivate the land. Here Sir William Willcocks places his "New Egypt," which he prophesies will extend as far as Sennaar.

At Khartoum another fine Abyssinian river joins the Blue Nile. (The main stream from its colour is called the White Nile.) This well-watered corner of the Sudan delights the enthusiastic Apostle of Irrigation. He waxes eloquent over his fancy-picture of the derelict plains of Meroe and Sennaar being revolutionised like the Punjab. Thirty years ago, he tells us, the sandy plains of the Punjab supported a miserable scanty population, which depended on a poor and fitful rainfall for a precarious existence. To-day these same plains are covered with millions of acres of cereals and teeming villages depending on the flush irrigation from the great canals constructed by the Indian Government. He prophesies that the Meroe and Sennaar Peninsulas will be traversed by

perennial canals, and will become the most prosperous regions in the world, producing quantities of cotton (so much needed in Lancashire now), cereals, and green crops.* Sir William Willcocks says "a rich soil endowed with flush irrigation will be attracting hundred of thousands of Egyptians from the densely packed provinces of Kenah and Girgeh, who will be converting those desolate plains into smiling fields."

To-day it seems hopeless to get a single *bonâ fide* immigrant to the desolated land, but Sir William Willcocks is no visionary, his work in Old Egypt is a guarantee of the wisdom of his counsel. Certainly, anyone who has visited New Khartoum and seen its beautiful Palace Gardens will admit what irrigation can do in such circumstances. The sooner a beginning is made to do something for the irrigation of the Sudan the better, for the country as it is, is a heavy charge on Egypt. Meantime, the great obstacle is the absence of population, owing to the disastrous effects of the Khalifa's cruelty, and the raids of slave-dealers.

NEED FOR AN IMMEDIATE IRRIGATION SURVEY.

Since the conquest by Lord Kitchener, the authorities have not been idle. Lord Cromer himself voyaged by the Nile as far as Gondokoro recently, wishing to see for himself the passage

* Egypt is likely to become one of the great sources of cotton-supply for Great Britain. Specimens of cotton grown in the Sudan have recently been pronounced by experts to be in every way superior in quality to Egyptian cotton.



FIG. 7. THE ASSOUAN RESERVOIR—VIEW AT SUMMIT LEVEL, WINTER OF 1902-3.

Showing the submerged Temples of Philae and the Kiosque of Augustus ("Pharaoh's Bed"), looking west.

through the "Sudd" (which Major Peake and other heroes had cut* to free the Nile's course), and generally to study the question on the spot. Sir William Garstin, who may be described as Lord Cromer's right-hand man, has lately returned from an arduous journey from Cairo by Suez and the Red Sea to Mombasa and Uganda. Thence he took the British railway and steamers to the Lakes Victoria and Albert, and descended the Nile by Wadelai and Lado, through the entire Sudd region to Fashoda by the Blue Nile to Khartoum. This wonderful journey, by a man who had only recently recovered from an attack of illness, deserves our admiration. It may be safely anticipated that the outcome will be a serious inquiry into the whole question of saving the Sudan from debt and penury by the means of a great irrigation scheme. We have shown that the Egyptian Government will soon be in a position to find the money for such an enterprise. Sir William Willcocks was given three years to survey and report on the great Reservoir question in Egypt. He is not now available, but there are good men in Egypt, quite fit for undertaking an irrigation survey of the Sudan, and it should be done at once.

Sir William Willcocks suggests the formation of great works at the outlet of the Nile from the Central Lakes, to raise their level. He also has a plan of his own for permanently keeping open a channel through the Sudd, and other extensive works on the White Nile. Lord Cromer, however, wisely counsels these costly works beyond Khartoum being delayed for the present until the whole Nile Valley has been surveyed, and the mysteries of the great river's vagaries are fully understood.

The clearing of the Sudd has left the passage for steamers free to the great Lakes. The River Nile has returned to its good old ways, the high Nile of 1903 being one of the best, and these costly works can wait. In the meantime, the irrigation of the region which Sir William Willcocks calls "New Egypt" does not involve any gigantic engineering works at the White Nile or at Lake Victoria.

It merely manipulates the River Atbara and

* Fortunately for Egypt the Kalifa was annihilated in November, 1899. Within a month of the final victory Sir Reginald Wingate had started an expedition under Major Peake, R.E., to remove the Sudd, which blocked the Nile between the 7th and 10th parallels of latitude in the Bahr el Gebel. The expedition consisted of four or five gunboats under two Naval officers and some thousand convicts. This work cost £15,000, and the water liberated was of sufficient quantity to save Egypt from drought, and made a present to the country of an increase in the crop of cotton valued at £4,000,000.

the Blue Nile, and could be proceeded with. But the survey must be undertaken first.

FINANCE.

Sir William Willcocks estimates the cost of the project for irrigating the Island of Meroe from the Atbara to Blue Nile at some £10,000,000. The land when irrigated would be worth £20 per acre, and two million of acres now barren would be irrigated. It is a healthy district of the Sudan, and could easily produce two crops every year. From the return we have already seen from the Willcocks dams in Egypt, there seems no reason to doubt the accuracy of the figures. Regarding the millions required for the Nile reservoirs now completed, Sir Ernest Cassel and his friends found the capital when the "Caisse de la Dette" refused it, although they had a large reserve saved by Lord Cromer's management. As money was supplied for the great Reservoirs by outside capitalists, no doubt the necessary funds could be also so obtained for the Sudan, should the Government shrink from raising the money themselves.

The great question is the want of population. Sir William Willcocks knows the Egyptian fellaheen intimately, and he believes they will be quite willing to colonise his "New Egypt" when it is made fertile by irrigation. He shrewdly points out that the present annual loss to Egypt by the Sudan is some £400,000, which, capitalised, amounts to £10,000,000. He believes that a proper system of irrigation for the Sudan will wipe out all this loss, bring in, in a few years, an enormous profit, and secure Egypt from famine and from floods for all time.

CONCLUSION.

We can rely on Sir William Willcocks; we know him by his works, and on such matters his advice should be followed as soon as Lord Cromer sees his way to do it. The matter may safely be left in Lord Cromer's hands. No pro-Consul was ever more astute, more tactful, more just. A born diplomatist, he has cut the Gordian knot of Egyptian finance, and has settled the question to the satisfaction of the interested Powers and their subjects. In devoting his life to the regeneration of Egypt, he has added a new glory to the British name as the protector of the weak, the only nation that is the determined enemy of slavery. And Lord Cromer's great work in Egypt is not yet complete. Long may he be spared to carry on his beneficent rule in the Land of the Nile! His modest official title is "British Consul-General," but he is to-day the virtual ruler of Egypt, and sways the destinies of the most ancient community in the world.

NEW DIVING TORPEDO BOATS.

By HERBERT C. FYFE.

*A*₁—THE largest submarine boat yet built for the British Navy, arrived at Portsmouth a few weeks ago, and is now being submitted to a series of exhaustive trials.

The Navy Estimates for 1901-2 provided for five submarines of the *Holland* type. These boats, "Nos. 1-5," are very similar to the newest American submarines of the *Adder* type. The Navy Estimates for 1902-1903 provided for four submarine boats of a new and improved type. These are known as *A1*, *A2*, *A3*, *A4*. All nine vessels have been built by Messrs. Vickers, Sons, and Maxim, at Barrow.

The Navy Estimates for 1903-1904 provided for ten further diving torpedo-boats, and an order for these has just been placed by the Admiralty with the above-mentioned firm. They will be known as *B1*, *B2*, *B3*, *B4*, *B5*, *B6*, *B7*, *B8*, *B9*, *B10*, and will be the biggest submarines in the Royal Navy.

It may be interesting to compare the first five boats with the four newer craft. The details of Nos. 1-5 are as follow: Length, 63 ft. 4 in.; beam, 11 ft. 9 in.; displacement (submerged), 120 tons; surface motor, 160-h.p. gasoline engine; sub-surface motor, 70-h.p. electric motor; speed on surface, 8 knots; speed below surface, 7 knots.

The *A1-A4* class have a length of 100 feet; beam, 20 ft. displacement (submerged), 200 tons; surface motor, 200 h.p. petrol engine; sub-surface motor, 70 h.p. electric motor; speed on surface, 15 knots; and below surface, 10 knots.

Considerable difficulty has been experienced in driving *A1*—the only one of its class which has up till now been put on trial—below the water. In

the "awash" condition, *i.e.*, with ballast tanks full and only her conning tower showing above the water, she is driven under the waves by her pair of horizontal rudders at the stern. Nos. 1-5, all now at Portsmouth, behave very well in this respect; they disappear quickly beneath the surface, and can be brought up again equally speedily when the commander wishes to take his bearings from his position in the conning tower. It is, of course, essential that a diving torpedo-boat should be able to dive and rise in a few seconds, for, in spite of periscopes and optical tubes, it will still be necessary in an attack to come to the surface every now and then to take note of the enemy's position. Unless the submarine disappears again before many seconds have elapsed she will be exposed to the terrific fire that will be poured upon her by the quick-firing guns of hostile ships, and will stand a good chance of being sent to the bottom by the fleet torpedo-boat destroyer, armed with its explosive boom.

The general opinion seems to be that the chief reason why it is so difficult to submerge *A1* is the fact that she has not sufficient horse-power. Her petrol engine is not sufficiently powerful to effect her submersion, and it is stated that the mechanical arrangements for assisting in the submerging of the vessel do not work with efficiency. Possibly, if fitted with side rudders, as are the French *Gustave Zédé* and the American *Protector* (*Lake* type), *A1* might be made to submerge more rapidly than she does at present. The British submarine No. 5 is shown in the accompanying illustration, and forms an interesting contrast with the new Russian submarine illustrated below.



THE NEW RUSSIAN SUBMARINE BOAT, THE "PERR KOCHKA."



BRITISH SUBMARINE NO. 5 AT PORTSMOUTH.
(See article on "New Diving Torpedo Boats.")

OUR MONTHLY BIOGRAPHY.

SIR WILLIAM EDMUND GARSTIN, K.C.M.G.

SIR WILLIAM EDMUND GARSTIN, nominally "Under Secretary of State for Public Works in Egypt"—really the acting Prime Minister of Egypt—is a remarkable man. He was trained to irrigation engineering in India, where he rapidly rose to notice. He was one of that intrepid band of young engineers, who, by Lord Dufferin's advice, were sent to reorganise and develop the resources of Egypt. He first saw Egypt in 1885, and in 1892 was appointed Inspector-General of Irrigation. But his duties extended far beyond that of controlling the irrigation, and in everything he has been called upon to do, he has shown his rare talent, tact, and power. Born, like his former coadjutor, Sir William Willcocks, in India, he was well fitted for work in a tropical country, and his mastery of the Arabic tongue makes him popular with the crowd of native officials and employés of the Government Services.

Lord Cromer has had his help in many delicate arrangements, such as readjustment of taxation and the revaluation of the cultivated land, and he has had several diplomatic missions. He has undertaken many tours of inspection to the distant provinces.

Sir W. Garstin recently made a remarkable journey by way of the Red Sea to Mombasa. Thence he made a tour in Uganda and to the Abyssinian frontier, the White and the Blue Niles, the Great Victoria Lake, and other waters of Central Africa, returning to Egypt by Gondokoro, Lado, Wadilai, Fashoda, Lake No, and through the entire Sudd region of the Bahr el Gebel and the Bahrel Ghazel. The cutting of channels through the Sudd is especially of his planning, and Major Peake and other officers employed on that arduous undertaking acted under his direction.

Sir W. Garstin is Lord Cromer's right hand man. He is always ready for any difficult job, either in engineering or any other branch of the service. The amount of work he is capable of is extraordinary. His despatch to Lord Cromer in 1901, with a report as to irrigation projects on the Upper Nile, with the graphic description

of his wonderful expedition through the poisonous Nile swamps, reads like romance. Being only published as a Blue Book (Egypt, No. 2, 1901), it has not much chance of being seen by the general public.



SIR WILLIAM EDMUND GARSTIN, K.C.M.G.

One of His Majesty's Under Secretaries of State for Public Works in Egypt. Grand Cordon Medjidie, Second Class Osmanieh, etc., etc.

His last journey (1903) by the Red Sea to Mombasa, and through Uganda and Lake Victoria to Khartoum, was his crowning feat of exploration. The report of this great expedition has not yet been published, but is looked for with much interest.

Sir W. Garstin takes a great interest in the antiquities of Egypt, and is one of the committee for the control of their exploration and conservation.

How to Educate an Electrical Engineer.

BY

E. KILBURN SCOTT, M.I.E.E., A.M.Inst.C.E.

In response to a number of inquiries, and believing that a paper on this subject by a practical member of the electrical engineering profession will be useful to students, parents, and guardians, we asked Mr. Kilburn Scott to undertake the following article. In addition to a careful outline of the training necessary, the writer deals with various pit-falls to be avoided by the embryo electrical engineer.—Ed.

I SHOULD be pleased if you could inform me where you consider the best place to educate a boy for electrical engineering, and at what age he should start."

Every engineer is constantly receiving such communications, and finds them somewhat embarrassing, because (fortunately), human nature cannot be deduced to a system or a formula, and therefore what is good advice for one boy is not necessarily the best for another. There are also many branches of electrical engineering—thus, electric light and power, electric traction, electro chemistry and metallurgy, besides other branches—telegraphy, telephony, wiring and fitting—these latter, however, are not so much an engineer's as an electrician's job. Hitherto there has been far too much electrician and too little of the engineer in the profession. After all, wiring is nothing more or less than glorified plumbing; an electric joint does not require nearly so much skill as making a wiped joint to a lead pipe.

The writer will assume that the inquiry refers to electrical engineering, with the stress on the word "engineering."

CHARACTER AND TACT.

Before everything else a boy requires character and tact, for the engineering profession is one which carries its members into every part of the world, and they are constantly called upon to direct affairs and set an example socially as well as technically. After all is said and done, the great feature of English life is the home training, and it is in the early years and especially just before entering into the business of life that character is formed.

If, therefore, by staying a little longer at home or at school a boy is thrown into contact with those having high ideals, then the purely technical training may well be deferred another year or so. If the boy is to attain any position at all, he will need to be a *leader of men*, and in some cases on a considerable scale. Initiative and decision of character are therefore essential.

PHYSIQUE.

The parents who start a boy in engineering having poor physique or poor health are much to blame, because the profession is essentially one which calls for a robust constitution. To get to work at six in the morning, and keep at hard manual labour all day, amongst noisy machine tools, is in itself a considerable strain, but this is not all. When home in the evening he must study text-books, attend evening classes (in moderation), study the technical journals, etc., or he will "get left."

Independently of this, however, sound physique and a good address go a very long way when the commercial side of the business is reached. The writer is of opinion that military training is necessary, and, if the boy has not been in the school cadet corps, he should join the volunteers, (if in London the electrical engineers) as soon as he is old enough. It should be remembered that the success of the Germans is as much due to the qualities brought out by their military training as it is to their great facilities in technical education.

EARLY EDUCATION.

A liberal education is essential, and its aim should not be so much to fill the boy's head with knowledge, as to make him quick to assimilate *special knowledge afterwards*; in other words, to teach the boy how to learn. If, whilst at school, he is able to take up some handicraft, such as carpentry, it will be as well, for, when he goes into a regular workshop, and the men see that he can already handle tools, they will respect him all the more.

In the school curriculum mathematics and French or German should take precedence of Latin or Greek, but the writer does not say the latter should be omitted. As a matter of fact, Latin is most useful in the assimilation of modern languages, especially as the boy may in after life have to learn Spanish or Italian. Freehand and geometrical drawing are necessary for accurate and rapid sketching, but the designing engineer of to-day must also be something of an artist, and train his imagination. Some of the cleverest engineers are most artistic.

Coming to science, the only two subjects which a boy need trouble with at school are chemistry and physics. These can be easily learnt whilst at school, and chemistry especially, is useful in every walk of life. In electrical engineering it is particularly helpful because of the great developments which are taking place in electro chemistry and metallurgy; in fact, there is more scope in this branch than in either electric lighting or electric traction.

We will now suppose the boy is sixteen years old. The next step is to get him into some small mechanical engineering workshop, for the parent must remember that electrical *engineering* is essentially mechanical. When one considers that in a central station 75 per cent. of the machinery consists of boilers, engines, condensers, pumps, water softeners, piping, valves, and that the design of a dynamo machine is practically a piece of mechanical engineering design, it will be seen how important it is that the purely mechanical training should take precedence.

PREMIUMS.

It would, perhaps, be well at this stage to say something regarding the payment of premiums.

If it can possibly be managed, it is best not to pay a premium for a boy to learn shop work, *i.e.*, fitting, turning, etc.; it is much better for him to go as an ordinary apprentice, and keep the regular shop hours. There will be more use for the money later on in giving him a sound college education, or with some leading consulting engineer, or possibly starting him in business. Paying a premium to an individual in *private practice* is a different matter from paying it to a company, where it merely goes to swell dividends, and there is usually no obligation on any individual's part to see that the boy gets value for the money.

There are, of course, exceptions. Some engineering firms having a well-thought-out system of training their young men, and in some cases engage an engineer specially to look after them, and deliver lectures, etc. One North of England firm the writer knows divide their apprentices into three classes, and have the following regulations —

1st Class.—Apprentices can keep their own time; can be moved from one shop to another as they desire, and finish their education in the drawing office. Term of engagement not less than three years. Premium, £120 per annum, paid in advance.

2nd Class.—Apprentices to keep the regular hours of the shop, failing which they render themselves liable to be discharged without notice, and forfeit the premium paid. They will be removed from one shop to another when the company considers them fit for the change, and will be put in drawing office should they be considered suitable. Term of engagement, three years. Premium, £80 per annum, paid in advance.

3rd Class.—Apprentices to keep shop hours as in second class. They will only be removed to another department as it suits the company, and will not be taken into the drawing office. Term of engagement, three years. Premium, £50 per annum paid in advance.

That a premium is not absolutely necessary is shown by the fact that the writer was with this same firm sixteen years ago, and went through their fitting and erecting shops, worked at the lathe, and also spent some time in the drawing office. During all the time he was employed as an ordinary hand, keeping the usual hours, and receiving a fair weekly wage, besides sharing in the piece money when any was made. At that time the firm took premium pupils, but they did not appear to have any special advantages. Perhaps things are a little different now, as the firm has been bombarded with applications for boys to enter their works.

A POINT TO BE WATCHED.

An important matter, which should be watched carefully is that several technical schools, or so-called colleges, make a pretence of giving their students a complete practical, as well as theoretical, training. It is hardly necessary to say that this is the greatest nonsense, for practical work *must be learnt in an actual works* to be of any use.

If the youth goes to a college at all, it should be to one of the very best, because the engineer who is to take a leading position requires breadth of thought, originality of method, and acquaintance with the world at large rather than to merely fill the brain with ill-assorted or half-digested information. It is for this reason that the all-round well-educated man is better fitted to conduct an important business concern than is the ill-trained product of a cheap technical school.

The writer is entirely against sending a student to college before he has been in a works, because he may attach too much importance to pure theory and too little to practice, whilst some college students are apt to sneer at dirty work, and this causes them to be disliked by the workmen, who are, after all, their teachers for the time being. A working mechanic is the last person in the world to give a young man any information if the latter puts on "side."

THE SMALL WORKSHOP.

A search through the biographies of those who take any important position in the profession will show that a large proportion were originally trained as mechanical engineers in *small shops*, and that they afterwards *drifted* into electrical engineering work.

The question therefore resolves itself into how best to pick up the necessary mechanical experience and afterwards the additional electrical knowledge, both theoretical and practical. One great advantage in going into a small shop first is that there is generally a *local concern* where one can get a start, and the boy is thus kept in touch with his home. This is important, because life in lodgings, away from all social intercourse with relations and friends, is not a good thing for a young man still in his teens.

In small shops a sharp boy soon learns to use most of the machine tools, drilling, planing, shaping, and the lathe, besides drawing down and tempering his own chisels, etc. He may also have to tend the engine and boiler, and, in fact, do all kinds of odd jobs. Outside repair work amongst various classes of machinery is also a most valuable experience; in fact, the more millwrighting in character the shop is, the better the training.

The writer was for two-and-half years in the oldest established millwrights' shop in the country, and the *general experience* gained whilst working out in various North of England textile factories, leatherworks, etc., has been valuable. For any one going to the Colonies it is excellent training.

If possible, the embryo electrical engineer should enter as an ordinary lad, starting at six o'clock in the morning, and receiving a wage of 5s. a week to commence, rising, say, 2s. 6d. a year. These are small wages, but it is a mistake to be in too great a hurry to earn money, as it may handicap the learner by keeping him too long at one job. The boy must always keep well in mind the fact that he is not going to *remain a mechanic*, but is in the shops merely as a steppingstone to something higher.

In such a shop as the above there is generally a certain amount of pattern-making, packing case making, etc., and the school carpentry work will come in handy for this. If there is a brass or iron foundry, try and get a little time in these, for it is in the pattern shop and foundry that one acquires that special knowledge necessary to become a trustworthy and *economical* designer. It is quite impossible, and, in fact, unnecessary for the youth to become a skilled workman at any of the above-mentioned trades, but he will pick up enough to see how the work *should be done* and to be able to detect any shoddy work or malingering when he attains a position of responsibility, and has men under him.

In this connection it is well to remark that the young man should take every opportunity to become intimately acquainted with the men, without being too familiar. He should become acquainted with the men's aspirations and ideas of fair treatment, and the organisation and inner working of their unions, for the successful master of the *future* will require to be on

good terms with and in sympathy with his employés. There are all sorts of little matters, such as various systems of paying by piecework, which the youth may be puzzled with at first, but which he soon becomes conversant with, particularly if it affects his own pocket. A useful boy may also be called in to do odd jobs in the office, such as making a tracing, going round to pay accounts, reporting upon a breakdown, etc.

Sometimes, where there is no premium or indentures entered into, there is danger of the youth being kept at one job, say the shaping machine or lathe, too long, for, naturally, there is a temptation to keep him at work which he already knows. To check this the boy should report at regular intervals to his parents or some friend as to the kind of work he is engaged upon. If there is any sign of being kept too long at one job, a little backsheeh to the foreman or leading hand will generally rectify matters. The writer's experience is that it is not wise to go to the principal of the firm if it can be avoided. He is usually a busy man, with more important things to look after, and, besides, the foremen are apt to resent it.

EVENING CLASSES.

Whilst he is going through the shops the youth must systematically attend evening classes in machine drawing, practical, plane, and solid geometry, applied mechanics, and steam under the Science and Art Department; and also, later on, mechanical engineering and electrical engineering, if there are classes for these subjects, for the City Guilds' certificates are worth having. If he has been well grounded in chemistry, physics, and mathematics at school, he will not now have to trouble about these, but metallurgy and iron and steel manufacture are good subjects to study. He must make a point of understanding the value of curve plotting, and he cannot do better than thoroughly master Professor Perry's most excellent lectures in "Practical Mathematics," published by the Science and Art Department.

It may be mentioned that the student who wishes to become an engineer must not carry his thoughts too far into the regions of pure science and higher mathematics, for an engineer learns much from *approximations*, which the pure scientist or the mathematician would consider hopeless. A knowledge of the differential calculus is useful, but is certainly not absolutely necessary. It is necessary, however, to become thoroughly expert in the manipulation of the slide rule, for in the drawing office or estimating departments, it is so useful for working out quantities, weights, costs, etc. It is quite a common thing to see foremen using the slide rule in Swiss and German electrical works, which reminds the writer that he has often seen those clever old millwrights, who unfortunately are becoming now so scarce, making calculations with the brass slide in an ordinary two-foot rule. The slide rule, by the way, is now admitted at most of the technical examinations in the subjects mentioned above, and is a very great help.

In case the youth is so situated that there is no large town where evening classes can be attended, then he must pick up his theoretical knowledge by systematic reading of text-books with some older friend to guide him, or there is another course, namely, entering his name with one of the correspondence schools. The best of these schools have their headquarters in the States, and it is really remarkable how much information may be acquired in this way. The writer has known several young men who have benefited considerably. It is only fair to mention that in connection with technical work the

correspondence system is not improperly used for the purpose of *cramming for degrees*.

COLLEGE TRAINING.

Having completed his two or three years in the small shop, we now come to a point where the future depends on the financial status of the parents. The writer had to depend for his theoretical knowledge on evening classes, but he knows well the limitations of that method, and is of opinion that money spent in giving a youth a full engineering course in a first class college is well spent. In the old days it did not so much matter, but nowadays high scientific requirements are necessary if the youth aspires for a leading position in the profession. Others set the pace, and he must follow or "get left." The crowded technical colleges in America and on the Continent, all equipped in the most complete manner, testify to the great change which has taken place in ideas of engineering education. So much is the college graduate appreciated by engineers in America, that often, before they leave, the brighter students are offered good situations.

In England college fees are higher than in the States or on the Continent, and parents may well consider whether they would not let their son take his college course abroad. Several of our smartest young electrical engineers have attended Continental and American polytechnics and colleges, in some cases also going through foreign workshops. Of course, we have various scholarships and exhibitions, and many deserving young men have been assisted in this way.

If the college course cannot be taken, the youth should enter a large electrical works as improver. By hard work and some tact he should be able to move about, and may eventually get on to outside erecting work, or the test bed, or in the drawing office. The large new electrical works, which have been established in this country offer much greater opportunities for improvers than some of the older concerns. They will have none of the premium system; everybody starts fair, and from what the writer has heard, ability is quickly recognised and rewarded.

A good deal of what follows will naturally be applicable also to the young man who is not able to have a college training, and it is by no means to be taken for granted that the college-trained man will beat his less fortunate student. Many of our most prominent engineers had no college training. The student should remember that the greatest efficiency is attained by not attempting too much, but by *doing well* the work he has in hand. On no account should he let a difficulty pass without at least attempting to find the solution.

ITS PRIMARY AIM.

The primary aim of a college training is to teach the youth to reason scientifically, and think about and discuss engineering problems, so that he is not merely a man who carries out the ideas and inventions of others, but can himself originate. The work of an engineer proper, as distinguished from that of a mechanic, is headwork rather than handiwork, and his proper sphere lies in thinking and scheming, and in applying that knowledge which has been defined as "the art of *directing* the Great Sources of Power in Nature for the use and convenience of man."

The word *directing* here is the key to the situation. In the past, theory lagged behind practice, whereas we have now reached a point where theory leads the way, and must therefore be studied in advance. In these days of keen competition, engineers are obliged to use the *minimum amount* of material and labour,

and also give strict guarantees of the general fitness of their work. It is only by judiciously combining theoretical knowledge with practical experience that this can be done.

In many of the best colleges original research and experiment are carried on to a considerable extent, not merely by the teaching staff, but by the students themselves. There are always problems cropping up which require investigation, and for which engineers engaged in active professional work have neither time nor facilities. These are more and more being investigated in engineering colleges, and in Switzerland and Germany it has been a great factor in drawing together the works and the technical colleges or polytechnics as they are called.

CHOICE OF A COLLEGE.

In choosing the college a good deal depends on the personality of the professors and their assistants, for the boom in technical education has, like all exaggerated movements, had a tendency to overrun the mark. The sudden demand appears to have exceeded the supply of good technical teachers, whilst the low salaries offered do not help matters.

Engineering at Cambridge has recently ranked high, but both Professors Ewing and J. J. Thompson are now leaving, the first going to the Admiralty, and the second to the States. Cooper's Hill has a good name, whilst in London there are the Royal School of Science (Professor Perry), University College (Professor Fleming), Central Technical Institution (Professor Ayrton), Finsbury Technical College (Dr. S. P. Thompson), King's College (Professor Ernest Wilson), and so on. In the provinces there are the Yorkshire College, Owens College, Durham College of Science, and the Glasgow University, etc. The usual course is for the student to aim at getting his B.Sc., or, at any rate, the Associateship of his college, but there are other advantages. Thus, the student will attend the debating society, or engineering club, and learn to express himself tersely and to the point. Tone and the making of acquaintances are useful features of college life.

THE TECHNICAL INSTITUTIONS.

The young man will in due time become a student of the Institution of Electrical Engineers, and, possibly, also, the Institution of Civil Engineers, if he can obtain the necessary signatures, and pass the examination. The Institution of Mechanical Engineers and the Iron and Steel Institute, etc., are useful to join after being in business for some time. The limiting age for students in both the institutions of Civil and of Electrical Engineers is twenty-five years. Before that time arrives the young engineer should have specialised or had particular experience in some branch of engineering, and he will be well advised to collect together all the data he can on the subject, and write a paper for one of the above mentioned Institutions. Premiums are given for the best papers, and the Miller scholarships and prizes of the Civil Engineers are most valuable on account of the standing which they give to those fortunate to secure them.

For the very clever student there are various scholarships, such as those associated with the famous Engineer-Whitworth, also National Scholarships, which are often won by engineering students. These, however, call for exceptional abilities in the passing of written examinations. The student would be wise to not reckon too much on examinations, as they are, after all, only a poor guide compared with the test which life puts upon us. In the affairs of the world the brilliant student is often beaten by some classmate

of only medium ability. "Memory men" are not usually the best material for engineers.

VACATION WORK.

During the college course there will be the usual long summer vacations. These should be spent in practical work of some kind, either on a temporary job in a mechanical or electrical engineering establishment, or in some civil or mining engineering work. This has been the practice in Scotland for some time, and it is somewhat similar to the so-called sandwich system, in which the usual college course of two or three years is extended to four or five years, six months or shorter periods being taken alternately at the college and in a works. In this way the student's interest in the theoretical side is stimulated. Continuous rounds of lectures from professors' notebooks are liable to get monotonous, and some educationalists and engineers appreciate this fact, and are trying to improve matters.

In the writer's opinion, if the student has already had shop experience in a small works, he can obtain most of the advantages of the system by employing his vacations in engineering work, or in travelling abroad and seeing foreign works.

Whilst on this subject, it is necessary to mention that the Testing and Training Institution of Charing Cross Road lays itself out specially to give an electrical training on what is practically the sandwich system. Various works and engineers in charge of electric light stations are affiliated to the institution, and by a payment of £100 a year for three years the student is moved about, and appears to obtain a fair training. Many students go as assistants in central stations pointer dodging on the switchboard gallery, or similar monotonous occupations. The system provides an easy way for parents to hand over their responsibilities to others for a fixed sum, but in the writer's opinion the electricians manufactured on this system are not brilliant.

LARGE ELECTRICAL SHOP.

In choosing the large shop, geographical situation goes for something; for the best engineering experience is undoubtedly to be obtained in the North of England and in Scotland. Life is more strenuous there than in the south, and the traditional engineering atmosphere has distinct value. It may easily happen that if a student has been successful at college his name may already have become known to the principal of an electrical firm, who may take him as assistant on the test bed. Of all departments in a works proper, the test bed is most valuable, for the student has opportunities of seeing everything going on, and if he is already a good mechanic, he can grasp all the details without actually working at them. He will also observe the method of organising and running a large business as compared with the small one he was in previously. With some experience of armature winding, he should soon be a valuable man to his employers to send out on outside jobs, and outside work is the thing to go for, as it throws one into contact with other engineers. Through it he may get a berth in some central station, or may possibly be taken on as assistant to a consulting engineer, or, as in several cases the writer knows, he may be sent out with a plant to the Colonies, in which case he will most likely be retained as resident engineer.

A good plan to pick up useful experience for central station work, whilst at the same time seeing something of the world, is to take a voyage or two as fourth engineer on a merchant steamer. If she is not a new boat, and there are some breakdowns *en voyage*, the

young engineer will be weaned from looking to the manufacturer in case of breakdown, which telegraphic facilities on shore are apt to lead to. He will probably also learn his own insignificance, a thing which must be learnt sooner or later.

Some men are cut out for office work, and in that case they should get into the drawing office as soon as possible, where, if they have ability, they will quickly pass to designing of dynamos, machinery, switchboards, transformers, and possibly engines, hauling gears, pumps, etc., also planning central station pipe systems, cable networks. There is great scope for good men in the drawing office, and the conditions of employment are much better than formerly. If he has a bent for invention—the writer means the genuine thing, not mere mechanical improvements—he would do well to accustom himself to making searches at the Patent Office Library, a most valuable institution, which is not so well known as it should be.

THE COMMERCIAL SIDE.

If the young man shows any ability for commercial work, the next step is into the estimating department, where he will learn the necessity for, as well as the absurdities of, specifications. He will learn how to take out prices from curves and prime cost sheets, analyse tenders, carry on technical correspondence, file data and catalogues, etc. Afterwards, he may be sent out to follow up inquiries, but this requires a particular temperament, good address, and much tact.

In this connection it is well to remark that if there is one thing in which the training of electrical engineers, as now carried on, breaks down, it is that very few ever get an opportunity to learn the commercial side of the business. Yet the engineer more than most men, is continually running up against questions of a financial bearing. As a result of this lack of commercial training, engineers are very often in the hands of non-technical people, such as accountants, secretaries, to say nothing of directors, figure-head and otherwise. This playing second fiddle to the purely commercial man is, after all, partly the engineer's own fault for becoming so absorbed in his technical work.

When being trained in the workshops the young man is cut off from all knowledge of accounts, correspondence, and commercial work generally, and when at college there is a silly sort of tradition that he ought to study engineering science for the love of it alone. It is considered *infra dig.* for questions of price to be brought into the discussion. To a certain extent this is right, but if he is wise he will begin to collect and study makers' catalogues even whilst at college.

Some engineers are fortunate to pick up commercial experience whilst they are learning the business, but for the majority this is not possible, and it is difficult to see how they are to be taught unless it is included in the college course. One thing is certain, that if the electrical engineer does not take steps to have more commercial sharpness, he will continue to play second fiddle to the purely commercial men. Several members of the Institution of Electrical Engineers have never had an engineering training; they depend on assistants and themselves watch the financial end. Personally, the writer considers there ought to be a rule preventing anyone becoming a full member of the Institution who had not had at least two years' workshop experience, not in clock making or glorified plumbing, but in heavy engineering work.

For anyone who has a special aptitude for the commercial side of the business, a little time in a general

shipping or merchant's office is excellent experience. A knowledge of commercial law, accountancy, etc. is also useful, for, besides technical information, there are innumerable things which the electrical engineer may have to tackle at some point of his career. In fact, no engineer worth the name ever finishes his education. There are, for example, such questions as the organisation of factories, the management of men, amalgamation with other firms, extension of works or moving to another centre, opening of branches and agencies. He must be able to appreciate at a glance the merits of an improvement or invention, know the peculiarities of the Board of Trade and Local Government Board regulations and restrictions, have a working knowledge of patent law, parliamentary procedure in connection with Bills, etc. He is just as likely to have to outline the buildings of a power house as to design a dynamo or transformer, and there is every probability he will have to face various problems of main line railway working. In electro-chemistry and metallurgy the possibilities are infinite.

PAYMENT.

Regarding financial results, it is a fact that for the majority they are only poor, for at the moment there is overcrowding. After years of practical work and a long period spent in mastering the theoretical side, a young engineer can consider himself lucky if he gets £120 a year. The fascination of electricity has resulted in drawing a very numerous and intelligent class of men into electrical engineering, and one has to work with indomitable energy and zeal to get into a position of prominence. There are many prizes, however, for those who can win them. Some electrical consulting engineers earn large fees, whilst the profits of electrical inventors have been pretty considerable. It is well to remember, however, that the value of a training is not to be gauged by the maximum salary obtainable in a minimum time. The thorough knowledge derived from varied experience will, in the long run, command the best salary.

One advantage which engineering has over some of the professions is that it is open to all, and, given ability and hard work, it is possible for anyone to rise to the highest positions. There is the freest competition, and, although in the earlier stages money may be a help, yet in the end ability is given every chance to show itself.

Everything points to the probability that in the near future engineers will attain to a position of considerable power and influence in the social organism. Their work in the management of large bodies of men, in organisation and financing, together with their accurate habits of thought, active life, etc., specially fit them to be leaders and advisers of men—in fact, statesmen in the true sense of the word.

When we look back, we find that in the beginning, when the world was superstitious and ignorant, its rulers were priests; then came the soldiers, who have disciplined it; and now we have the lawyers, who have established civil rights. Inasmuch as the great questions of the immediate future are industrial and scientific, the balance of power should lie largely with the engineers.

It rests with the engineers themselves as to how long this will take. Public opinion needs educating, and one step in this direction is for the engineers of to-day to take a greater part in public affairs. The public must be brought to recognise the revolution in industrial and social affairs which is resulting from the activities of the engineer.

THE MANUFACTURE AND USE OF CONCRETE.

BY

A. LEGG, M.Inst.C.E.

The previous article was largely devoted to tests of Portland cement for fineness of grinding, specific gravity, strength, hydraulicity, speed of setting and soundness. The author now confines himself to the essentials of good aggregates and their preparation, the computation of voids, methods of mixing, etc. He gives some practical hints on the working of concrete.—Ed.

II.

I SHALL now proceed to discuss the materials or aggregates which are to be used in conjunction with the cement to form the concrete. The essentials of good aggregates are:—

1. Hardness and density.
2. A moderate degree of porosity, *i.e.*, as opposed to a vitrified surface.
3. Angularity of fracture.
4. Variation in sizes of particles.

Broadly, one may group the aggregates under two heads.

1. Materials found in nature ready for use.
2. Materials prepared for the purpose.

GRAVEL.

Under the former head the only material which is used to any extent is "gravel," consisting of more or less rounded pebbles of varying sizes. From whatever source these are obtained the usual preparation necessary is screening and washing. This material does not fulfil all the conditions laid down. It usually possesses a smoother surface than is desirable to afford a good hold for the cement, and the shape is not angular, otherwise it is often very hard and durable, being, as it were, the survival of the fittest portions from the trying ordeal to which it has been subjected during a lengthened period in the rubbing or knocking together of the fragments in the river bed or sea-shore, whereby the softer portions have been reduced to sand or mud, and only the harder remains.

PREPARED MATERIAL.

Into the second class will fall, as by far the most important, all materials which are prepared by breaking or crushing the natural rocks, and these are the materials on which the engineer chiefly relies. This source is practically unlimited. Any rock which will furnish a building stone of good quality will, as a rule, also furnish good aggregates for concrete, and many rocks which do not furnish building material of good quality, owing to their hardness and difficulty of dressing, or to the difficulty of obtaining from them sufficiently large blocks, may produce very excellent material for concrete.

This class of material is generally superior to natural gravel. When broken it usually possesses great angularity and roughness of surface, and it is from this class almost exclusively that can be obtained material fulfilling *all* the requirements already given as desirable.

Much might be written concerning the different methods of reducing the rock to the sizes of fragments required. Suffice it to say, that stone reduced by a modern percussive action stone-breaker is preferable to that broken by hand, or by rolls, as it generally gives a greater variety in size of fragments.

One other small variety of material still remains to be mentioned, *viz.*, that obtained by the breaking of artificial substances, such as bricks, or clay burned in the rough specially for the purpose. This last is often useful when suitable rock or gravel is not to be had, and if thoroughly burned forms an aggregate which will make good sound concrete.

As to the best size to which to reduce the material, a usual stipulation is that it should all pass through a ring 2 in. in diameter, and for ordinary foundation work this gives excellent results, but when watertight work is required, 1½ in. gives better results. Of course, generally the cost is greater the finer the material, but, within limits, the extra cost of crushing the smaller size is compensated by the greater ease of mixing and subsequent working.

Having considered the various ingredients required in the composition of the concrete, we will now discuss the proportions of each of these which should be used, and the methods by which they are to be brought together so as to produce the best results.

It might appear that the engineer has here absolutely free scope, trammelled only by considerations of economy, but there are limits, and rather narrow limits, within which he must confine himself, if he is to obtain satisfactory results.

Here, again, as in other details, he is governed by the purpose of the proposed work.

DETERMINING THE VOIDS.

The following remarks as to the method of determining best proportions will apply to the production of watertight concrete, for which purpose the highest possible quality of work is required. For other purposes the engineer will allow himself such departure from the results obtained by these methods as his experience may warrant.

Having selected the particular material to be used for aggregates, the first step will be to determine the proportion of voids or interstices existing when a mass of the aggregates is thrown together. The proportion of *mortar* in the concrete must then be made sufficient not only to completely fill all these voids, but also to allow a sufficient excess to completely surround each particle of the aggregates, so that no two adjacent pieces shall touch.

The simplest method of determining the voids is to fill a vessel of known capacity with the aggregates and then measure the quantity of water required to fill the interstices, taking care, of course, to eliminate as far as possible any error from absorption.

The volume of voids being thus obtained, we must add a percentage to allow for the surrounding of each particle. From 10 to 15 per cent. is usually sufficient. If the quantity of *sand* used is alone made *equal* to the voids, the addition of the cement will generally produce sufficient *mortar* to cover this percentage, as will be pointed out later.

The actual percentage of voids will vary with different classes of material and with the size of the particles. Generally speaking, finer material having a smaller percentage than coarser, and more marked still is the effect of a great range of variation in the sizes of the particles, the smaller ones then filling the voids between the larger and reducing the total percentage. For material 1½ in. to 2 in. maximum and of varying size below that, the proportion of voids to total volume of aggregates will generally range from 35 per cent. to 50 per cent.

By a similar process we may determine the proportion of cement required to fill the interstices of the sand. It will be found that the voids in an average sample of sand will lie generally between the limits of 30 and 40 per cent., and that a sample showing more than 40 per cent. would probably be so coarse as to be looked upon with suspicion for use in watertight work, unless with the use of an excessive quantity of cement. One part of cement to two of sand will, therefore, generally be found to give safe results, but the engineer desirous of using a larger proportion of sand than this should satisfy himself that the sand is of suitable quality. It may be useful to point out here that the volume of cement paste resulting from the gauging of one volume of Portland cement with water is only about 80 per cent. of the volume of the cement dry. So that sand having 40 per cent. of voids would require 50 per cent. of dry cement to completely fill the voids.

SPECIFICATIONS FOR CEMENT.

Being now in possession of the knowledge of the proper proportions for the ingredients, what is the best method of specifying them so as to obtain exactly the resulting concrete which we desire?

Occasionally one finds the proportions specified simply by stating that the proportions shall be one part of cement to so many parts of aggregates, *e.g.*, 1 to 5 or 1 to 6, as the case may be. In letting a contract on such a specification the engineer is laying up for himself the possibility of many friendly discussions with his contractor.

It is not an uncommon practice to specify the exact proportions of each ingredient as one part of cement to so many parts of sand and so many of aggregates. Now, if the engineer in writing his specification has in view the use of definite materials, of which he has already obtained by some such method as that described the correct proportions, this is allowable, otherwise it is unsatisfactory, as he is giving himself the somewhat difficult task of finding materials to suit his conditions, and he may eventually find that by adhering to the proportions specified he is not using the materials available to the best advantage, *e.g.*, he may be using more sand than the aggregates actually require, and so obtaining a weaker concrete than he would otherwise get with the same proportion of cement.

The method which the author has found the most generally satisfactory is to specify that one part of cement shall be used to so many parts of aggregates and sand together, and that the proportion of sand to aggregates shall be such as the engineer may determine.

MIXING.

We now go on to consider the method of mixing the ingredients. As the quality of the resulting concrete will greatly depend upon the thoroughness with which this operation is conducted, it is one requiring careful consideration. The condition of perfection to be arrived at is that each grain of sand in the mortar shall be surrounded by a layer of cement paste, and that each particle of aggregate shall be surrounded by this mortar, which shall also completely fill all voids.

These results are, no doubt, most completely obtained when the sand and cement are first intimately mixed together in the proper proportions, afterwards adding the proper proportions of aggregates and thoroughly mixing the whole mass, and, if the sand and aggregates are delivered on the work separately, this is undoubtedly the best method of working. If, however, the aggregates and sand are delivered together as a product of the crusher or otherwise, it is not worth while to separate them in order to adopt this method.

IMPORTANCE OF THE DRY MIXING.

As to the actual process of mixing, there are now many machines in the market for the purpose, which give first-class results when properly worked, and when large quantities have to be dealt with machine mixing possesses many advantages over hand labour, more especially in a country where labour is dear. At the same time, very excellent results can be obtained by hand labour, which, for works of moderate dimensions, will compare favourably with mechanical mixing, both as regards quality and cost.

Whichever method is adopted, the most important part of the whole process is the dry mixing, one turning of the materials dry doing more to bring about intimate mixing than several after water is added.

Three mixings of the materials dry and two wet will generally suffice to produce good results. The water should be clean, should always be added very gently through a rose, and never poured on in a jet, or, worse still, out of a bucket, as is often done, as it simply washes the cement out of the mixture.

PROPORTION OF WATER.

The best proportion of water to be used is a question which has, perhaps, given rise to more discussion amongst engineers than any other point in connection with the subject, and with it is associated the question of best laying and working the concrete in. We have on the one hand the *dry* method of mixing, in which only sufficient water is to be used to enable a film of moisture to be brought to the surface by hard and continued ramming, and, on the other hand, the *wet* method, in which concrete is to be so sloppy and wet that it almost falls together without any ramming. Each of these methods has its advocates, who are, as is usual in such cases, inclined to ride their hobby to death; whereas, if used intelligently, each method undoubtedly has its special uses and advantages.

There can be no doubt that concrete made with a minimum quantity of water is stronger than one in which an excess of water has been used. This is established by experiment. Therefore, when strength is the most important factor to be considered, the concrete is best mixed fairly dry and well punned. There are many cases, however, where strength is not the most important factor, but is secondary to watertightness.

MAKING WATERTIGHT CONCRETE.

Now, whether or not watertightness can be obtained with dry mixed concrete, is the very point on which the controversy turns. As a result of considerable experience with both methods, I am prepared to admit that it is possible to obtain excellent results in this respect with the dry mixing; at the same time, I am convinced that the personal element enters far too much for it to be relied upon always to do so, and therefore, for safety sake, where watertightness is essential, I always prefer the concrete to be put in soft. Let me explain clearly what I mean by "soft."

1. The concrete should be so soft that one cannot stand upon it, when in a heap upon the mixing stage, without sinking over the boots.
2. There should be no *free* water, and never any suspicion of water *flowing* from the surface when it is being worked in position.

The actual quantity of water required to bring about this condition will, of course, depend greatly upon the porosity of the aggregates.

In this soft condition punning or ramming is useless. What is required is that the concrete shall be well worked or chopped into solidity with a thin narrow tool—an ordinary grafting tool is a very efficient

instrument—in such a way as to allow any enclosed air to escape and the mass to fall together by gravitation.

Concrete put in in this way need never cause the engineer a moment's anxiety as to whether or not it will hold water, whilst with concrete put in in the dry way, unless he personally sees every inch of it put in, he will never be quite free from a haunting fear that the water will by and by demonstrate that for a few moments, at one time or another, the very rigid supervision necessary had been relaxed.

Another danger to be guarded against with the dry mixing is, that the hard ramming necessary is liable to fracture the particles of the aggregates, and to leave the fractured surfaces without any mortar between them. And again, ramming has little or no effect in bringing to the surface included air, except from very near the surface, its effect is rather to completely seal it up in the interstices and render escape impossible.

Concrete should always be laid in moderately thin layers, not exceeding, say, 9 in., but it is better to lay about two or three such layers on each other immediately, so as to attain a thickness of, say, about 2 ft., rather than to allow each thin layer to set before adding the next.

SOME DEFECTS.

A careful examination of a large surface of concrete which has water under pressure behind it, and through which percolation is taking place, will generally reveal two causes of weakness. First, there will be found *patches* of larger or smaller extent and of irregular shape over which the water oozes. This is evidently a defect of mixing. The concrete in the patches has either been deficient in mortar, or else the aggregates have not been well mixed in, so that voids exist.

Secondly, water may be found oozing along a *line* which marks the junction of new work with old. This is a very prevalent defect. Too much care cannot be bestowed upon the bonding of new and old work. By old work is meant work which has already set. It may be but a few days old.

HINTS ON THE USE OF CONCRETE.

To insure a good joint the old surface must be absolutely clean, and a layer of mortar should be laid upon it for the double purpose of embedding any rough stones which will inevitably fall to the tail end of the new concrete being placed, and of filling up irregularities in the old surface and cementing the two portions together.

In laying concrete on wet foundations great care is necessary to prevent the washing out of the cement by the water present. I do not propose to deal with the laying of concrete under deep water, as this subject belongs more properly to a discussion on harbour works. I shall refer only and briefly to cases where concrete has to be laid in a position where it is found difficult or impossible to have the foundation dry, as frequently happens in deep pits for bridge foundations.

One frequently sees concrete mixed almost dry being thrown into a wet foundation, in order, as it is said, to take up the water lying there, and so keep it dry. This is very bad. The concrete should always have its full allowance of water in mixing, whether the foundation is wet or dry.

When the foundation cannot be made quite dry then the concrete should be placed in *from one side* in a sufficiently deep layer for the surface to be always above the water, and worked gradually across the pit, driving the water before it.

▶ If pumping has to be resorted to, it requires to be done with great care, so as to avoid washing out the

cement. It is a safe plan never to allow the surface of the water to be pumped below the surface of the layer of concrete being put in. Concrete may, with these precautions, be made quite as sound and water-tight on a wet foundation as on a dry.

The laggings used for face work should always be greased so as to come away without plucking the face, as the natural sink so obtained looks better and wears better than a face got up by floating or rubbing after removal of the laggings.

EFFECTS OF CONTRACTION AND EXPANSION.

When designing work to be constructed in concrete, it is well to keep in mind the effect of contraction and expansion, and, if possible, to devise some means of avoiding ill-results. Work carried out in masonry and brickwork does not call for any such precautions, because the effect being distributed amongst a large number of joints is so slight at any one point as to be negligible, but when we have a mass of concrete of great extent in any one dimension without any joints, it is necessary to adopt some precautionary measures.

Just what the exact coefficient of expansion for concrete is has not yet, so far as I am aware, been determined accurately, but it is evident that changes of temperature must produce great stresses in its substance, expansion giving rise to probably a certain amount of displacement or distortion (the amount of which will depend to some extent upon the particular form of the mass), and it is quite possible also that under certain conditions some effect might be produced analogous to that of cleavage in some of the older rocks, with the result that at such cleavage planes the strength of the material might be adversely affected. This, however, could only be expected to take place on the mass becoming confined, so that distortion or displacement could not take place even when the stress was approaching the ultimate crushing strength of the concrete, a condition which will not very frequently occur. Displacement will probably be the means by which compressive force, due to expansion, will most frequently make itself manifest.

Contraction, on the other hand, will subject the structure to tensile stresses, assailing the material on its weakest side, and after certain limiting dimensions have been exceeded will assuredly, under ordinary conditions, produce fracture in the structure.

I consider that a concrete wall of a length of 100 ft. and over, which will be exposed to the full effect of atmospheric changes of temperature, ought to have expansion joints provided. In a wall which has to hold back water, such as a reservoir wall, the joint must be so designed that, when it is most open, during the period of lowest temperature, the passage of water will be prevented. This may be accomplished by the adoption of some such device as a tongue of plastic bitumen within the thickness of the wall.

When this condition has not to be fulfilled, then such precaution is not necessary; indeed, the expansion joint then becomes unnecessary, except in so far as it selects the line on which the movement shall show, instead of leaving it to chance, which usually results in unsightly cracks.

A more satisfactory method of providing for expansion and contraction is by avoiding as much as possible long straight lines in the design, and adopting instead curved lines. The facing of the concrete with masonry or brickwork will also have a beneficial effect in reducing the range of temperature changes to which the internal mass of concrete will be subjected. The effects of often repeated expansion and contraction in a concrete structure is a very important question, requiring very careful investigation.

IS ANYTHING THE MATTER WITH PIECE WORK ?

BY
FRANK RICHARDS.

The author criticises premium systems in the light of practical experience, urging among other things that they offer a reduced incentive at the precise time when the need of incentive is most urgent.—ED.

ATTENTION is invited to the accompanying diagram, which is easily understood. The purpose of it is to show the actual earnings of the workman, and of course also the labour-cost to the employer, for any given amount of work done under either day work or piece work at different rates, the Rowan premium system and Mr. Halsey's premium plan. The amount of work done is represented by the lengths of the horizontal lines and the wages paid are represented by the vertical lines.

THE ROWAN SYSTEM.

The Rowan system starts with a fair day's work, although that may not be the term used to designate it. The unit assumed is the amount or quantity of work which the man should ordinarily be expected to do in a day for the ordinary day's wage without any special inducement. The premium is earned only by the work which is done in excess of the regular day's work, and the premium earned is according to the time saved in doing the work. If double the work is done in the given time then one-half the time is saved and the man is paid one-half in addition to his regular wages. If the man does one and a-half times his day's work then one-third of the time is saved and he is paid one-third more than his day's wages, and so on. The basis of computation is thus fixed and cannot be juggled with, but the inducement constantly decreases with the amount of work done, so that whatever a man may do he can never by any possibility double his earnings. Mr. Halsey's premium plan will be designated hereafter as *the* premium plan.

Referring to the diagram it will be seen that both day work and piece work, whatever the rate of the latter, are represented throughout by straight lines. A discouragement curve represents the Rowan premium system and Mr. Halsey's premium plan has a bend sinister. It was impossible to include Mr. Gantt's bonus system in the diagram because a part of it, the part where you do not quite earn the bonus, must be represented by an *invisible* line.

It cannot fail to strike the observer at once that in the premium plan the work which is done in the earning of the premium is straight, absolute piece work. The name cannot disguise it. The line in the diagram for the premium plan at one-half rate is exactly parallel to the half rate piece work line, the wages earned rise equally in each with equal increments of work done. So the three-eighth premium rate is parallel to the three-eighth piece work rate,

and so on. If in making the premium plan bargain, the proposition were made to the man to first do his allotted quota and be credited with his day's wages and that then he should go to work by the piece for the remainder of the day at one-half the day rate, that would be the premium plan in every particular.

THE PREMIUM PLAN CRITICISED.

The partial piece-work character of the premium plan being undeniable, a paper whose topic is piece work must claim the right to handle it freely and without apology. The premium plan was invented by its originator nineteen years ago; it was put in operation in the shop at Sherbrooke, Canada, thirteen years ago, and was first brought to the notice of this Society in a paper twelve years ago. The plan, I know, has been proposed and advocated in all honesty of purpose; it has been pushed with earnestness and

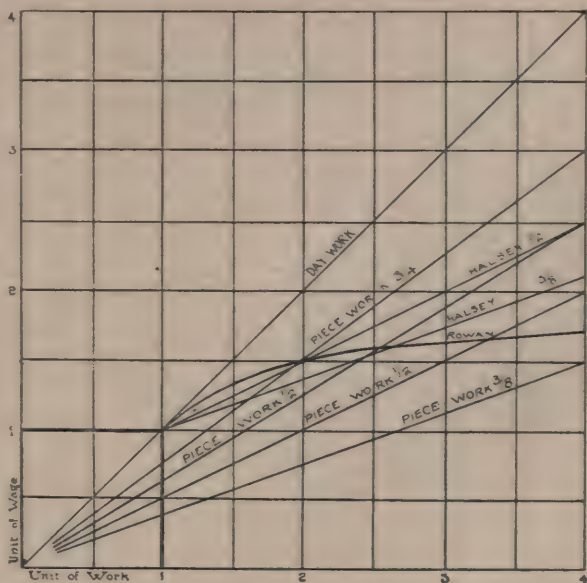


DIAGRAM SHOWING EARNINGS UNDER THE
DIFFERENT SYSTEMS.

persistence. As a result the premium plan is in operation in a few machine shops and nowhere else. I venture the personal opinion, based on the fullest available information, that perhaps two per cent. of the machine work in the United States is done under the premium plan, while ten times as much is done by undisguised piece work and much more than half is still done by the day.

It is not at all apparent that there are any peculiar conditions in the machine shop which demand any different plans of wage adjustment than are prevalent in the other trades. While a knowledge of the premium plan is now widespread, the plan has not made itself appear so good a thing that any of the other trades have taken it up. It would not work with the shoemakers of Lynn, the hatters of Danbury, the glove-makers of Gloversville, or the stitchers and starchers in the collar shops of Troy, for they all work by the piece, as do most of the manufacturing trades, and the ultimate possibilities of economical production are thereby secured as completely as they can ever be claimed to be under the premium plan.

HOW IT WOULD WORK WITH BRICKLAYERS.

We might by an effort imagine the effect of proposing the premium plan to one of the trades outside the machine shop. Let it be tried on a lot of bricklayers. Say that it is first agreed that the day's wages are earned when five hundred bricks are laid, and that the premium plan begins right there. The bald proposition is, first, that if five hundred bricks are laid five hundred bricks will be paid for. This is so far meant to be an honest bargain on both sides. If you don't lay another brick above the five hundred we will have no cause of complaint. Well, now, having agreed to pay for the laying of the five hundred bricks, when the five hundred bricks are laid go on and lay as many more as you can. If you lay seven hundred and fifty bricks we will pay you for laying six hundred and twenty-five bricks; if you lay one thousand bricks we will pay you for laying seven hundred and fifty bricks, and so on. It will be very plain that under this arrangement the workmen are clearly the gainers, for if you lay more bricks you get some more money, and every additional cent you get is, of course, clear gain to you. The absurdity of this thing, when dealing with bricklayers, is sufficiently evident; are machinists so vastly different from bricklayers?

They must be different or else there are some things about the premium plan upon which I need information. One of the inherent and inseparable conditions of the scheme would seem to be the voluntary acceptance of it by the individual workman. It depends entirely upon himself how much the man shall do after the allotted amount for the day's work is done. He may do much or he may do little, and therefore if he so chooses he may do none at all, but just be content to work along at his usual rate and just earn his day's wages. The premium plan, as I understand it, is ostensibly, entirely a coaxing and not at all a driving plan; and yet it is a matter of common knowledge that in the State of New York alone there have been two determined strikes against the premium plan in the past year. This seems odd. If you don't choose to do what you are formally and distinctly allowed to choose whether you will do or not, what possibility for a strike can there be in that? Can it be that premium plan enthusiasts sometimes venture to put on to the plan some features which do not belong to it? I cannot imagine any other way in which a strike could be possible.

THE CUTTING OF RATES.

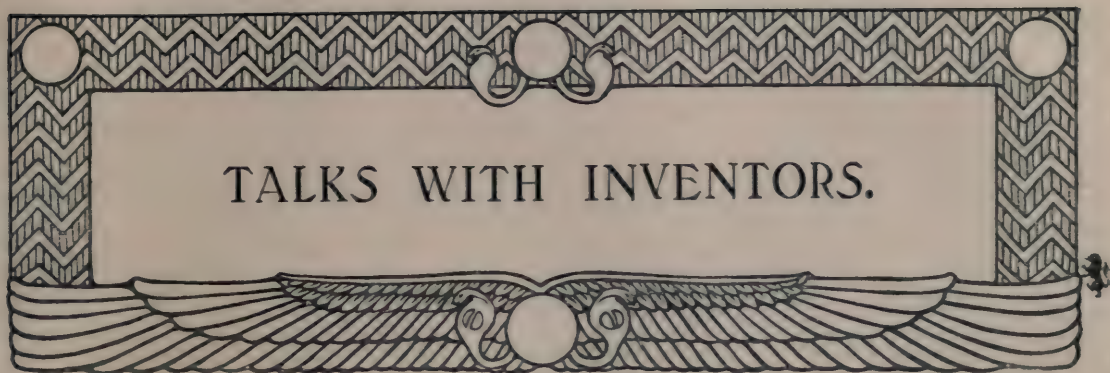
If they can tag things on and objectionably modify the premium plan they can also knock things off. The one essential safeguard of the premium plan continually insisted upon is that there shall be no cutting of rates when once established. This must inevitably involve injustice, because prices both of labour and of finished products change continually, and there must be, if justice is to prevail, sometimes a cutting of rates and sometimes an advance of rates. So far as it is possible to fix honest prices, and to maintain them there as long as it is just to both sides to do so, it can be done as well with straight piece work as with any premium plan, and is so done. For instance, I have knowledge of an establishment in the machine line, whose identity I must not disclose, where fifteen hundred men are employed and where piece work prevails in all departments, so that ninety per cent. of the productive work of the entire establishment is done by piece work, and it may be said of that establishment that there is no cutting of rates there, just as truly as I suppose it is ever said of works where the premium plan is in use. All prices when made run for a year. They are not arbitrarily imposed by the employer or his representatives, but are the outcome of fair and free and friendly conference, and when changes of price are imperative they are adjusted again in the same way. The works are prosperous continually, and the relation of employers and employes are less strained than they were under other arrangements.

It must be evident that none of these premiums or bonus, or other curved or bent, or defective line schemes, whatever they may claim in the way of quickening the pace of the worker and increasing the output, can be the most effective, for the reason that they offer a reduced incentive at the precise time when the need of incentive is most urgent. It is the last piece done which comes the hardest, and it is absurd to offer the man half-price or less for doing it. With either of the premium plans doing its best in the way of increased output and reduced labour cost per unit, and with piece-work prices adjusted to precisely the same price per piece, the inducement to the worker to increase his output still further must be greater under the piece work than under the premium plan. The guarantee that prices shall not be cut is precisely as applicable to piece work as to the premium plan. The latter has absolutely no monopoly of honesty, no assurance of price maintenance any more than the other. With equal temptation to cut, and with the same human nature in the boss, the chances of cutting will average precisely equal.

THE ADVANCE OF PIECEWORK.

With no one having the slightest interest in pushing or advertising piece work, it is advancing on its merits as the most honest way of paying for repetitive work in the machine trade as in all others. It is worth while to note its popularity and progress especially in the extensive line of railroad work. The testimony at the meetings of the various railroad organisations is very pronounced in this direction. At the meeting this summer of the Railroad Master Blacksmiths one man stated that absolutely every job in his shop was done by the piece. When the price could not be placed on the work to be done it was placed on the "heat." Perhaps it may not always be possible to do this in the machine shop, but whenever the opportunity arises to consider the mode of payment it should always be in order to ask: What's the Matter with Piece Work?

A paper read at the New York Meeting of the American Society of Mechanical Engineers.



I.—DR. BARTON, PRESIDENT OF THE AERONAUTICAL SOCIETY.

WHILE many engineers are deep in questions of electrification, permanent way and communication by tubes beneath the earth, it should not be forgotten that there are those who are no less deeply concerned in solving the problem of aerial flight—a problem which, if satisfactorily determined, would tend to place ordinary systems of transport somewhat at a discount.

The writer recently chatted with one of the most enthusiastic of these gentlemen who are endeavouring to make a conquest of the air. The scene was an immense wooden shed at Alexandra Park, open at one end to the sky. The aeronaut was Dr. Barton, President of the Aeronautical Society, whose airship, rapidly approaching completion, loomed large in the centre of the shed.

The ship is described by the inventor in another part of the Magazine. It is the largest airship yet attempted. The bamboo framework of the ship proper suggests its nautical prototype. It is nearly twenty feet in depth, and another forty feet has to be allowed for the cigar-shaped balloon. All the parts are either lashed together or clamped in castings of aluminium; it is innocent of nails or screws. A central deck or gangway runs from one end to the other, and connects up a number of platforms, which carry the machinery and crew. Three sets of movable aeroplanes—10 in each set—are placed in the bows, amidships and at the stern respectively.

We gathered in conversation with Dr. Barton, that he was born at Dover in 1861, and was educated at Harrow and Cambridge. He has always been fond of athletics, and some years ago rowed in the 'Varsity trials for Cambridge. He received his medical training at Cambridge, and in St. George's Hospital, London, and is

now President of the Medical Society at Beckenham, where he has been in practice for the last fifteen years.

It was over twenty years ago that Dr. Barton first took an interest in airships, and his first attempt at constructing one resulted in a model almost identical with the machine in which M. Santos Dumont encircled the Eiffel Tower. After constructing several self-propelling models on the purely navigable balloon system, Dr. Barton turned his attention to aeroplane machines, but finding both these unsatisfactory, he finally combined both principles, and after several experiments with models, was so successful that he secured an order from the War Office to construct an airship suitable for service in warfare. This is the ship now under construction at the Alexandra Palace.

Having taken careful stock of the ship, its aeroplanes, motors, ingenious ballasting arrangements, etc., we sounded Dr. Barton as to the time taken in the evolution of his idea.

"I was engaged for two years on the plans," he said. "Almost endless experiments were tried before even the materials of construction were finally adopted, and then, of course, every separate detail had to be carefully thought out."

"You have relied mostly upon bamboo?"

"Yes," said the Doctor, turning to a stack of bamboo masts about six inches in diameter, and many feet in height, "Can you lift this?"

The interviewer braced his muscles for a feat of strength, but in the result was able to lift it easily with one hand.

Taking a piece of thin bamboo, about 8 ft. long, the Doctor illustrated its strength and rigidity by showing that the bar would easily support the weight of a man.

"It has a great deal of silica in its

composition," he remarked, "and made short work of our sawing tools. Aluminium is the *metal* chiefly employed," he added, "and, as you see, steel has only been used for the shafts of the propellers and aeroplane frames."

"The machine is now practically complete, is it not?"

"Well, nearly. Under favourable circumstances I could make an ascent in a month."

Further questions elicited the fact that the delay is being caused not by any unlooked-for difficulties in construction, or even climatic reasons. Airship construction, just as ordinary shipbuilding, is subject to the ordinary difficulties and delays of commerce. Dr. Barton mentioned that the financial side of the business is occupying his attention, and he is making arrangements for the introduction of fresh capital.

"And you think that the *flying* machine has ultimately got to come?" we ventured.

"Unquestionably!" said the Doctor, with emphasis. "It is only a matter of time. You know how it is with a boy who is learning to swim. You hold him up with a cord to start with. Then, as he becomes more expert, you gradually loosen the cord until he can support himself by his own efforts. It is just so with the airship. I shall carry a balloon with sufficient hydrogen to keep her balanced just above ground; the aeroplanes will do the rest. Then, as our knowledge increases, this aid will be gradually withdrawn, until the ideal airship—that is, one composed entirely of aeroplanes and propellers, is arrived at."

"And the passengers?"

"The *crew*," corrected Dr. Barton, "will

consist of seven persons. My own attention on the first trip will be devoted to taking observations. There will be also three engineers, an aeronaut, a helmsman, and my boy, who, by the way, is a capital little engineer, and thoroughly understands the motors."

Here we were shown the telegraphic system by which, on the Bowden brake principle, all the engineers will be in communication with the helmsman's platform.

"Of course, in an airship of this description there will be no promenading of the deck; and we see that your helmsman is stationed almost in the middle of the ship."

"That is so; the helmsman will be stationed there in order that he may be as near as possible to the aeronaut."

Dr. Barton then explained the means by which the water ballast will be worked, remarking that this system of ballasting will now be used for the first time. He also showed us his arrangements for giving the ship an ascending or descending motion by means of aeroplanes.

"You have already made several ascents, we think, in the ordinary way?"

"I have not had many trips, but rather exciting ones. On Coronation day I crossed the Channel with Mons. Gaudron in a balloon."

"And had rather a rough time, we believe?"

"Well, we were caught in a gale off Calais. The balloon went bump into the sea on the flats outside Dunkirk. Relieved temporarily of the weight of the car, it rose abruptly, and carried us a little further, when we were treated to another bath, and so on—finally we were carried across the surf to land, but it was a narrow escape."



LOCOMOTIVE ENGINEERING NOTES.

French Locomotive Practice.

For several years past—nearly a decade in fact—the predominant feature of French locomotive practice has been the adoption and rapid development of the de Glehn compounds for express passenger duty. With the able and hearty co-operation of M. du Bousquet on the one hand and of M. Baudry on the other, this system was embodied in the express locomotive types constructed for the Chemin de Fer du Nord and the Chemin de Fer de P.L.M., quite early in the nineties. The de Glehn engines built for those two great lines differed mainly in respect of the diameters of the four driving wheels, those on the Nord line being 7 ft. and those on the P.L.M. 6 ft. 7 in. in diameter, while the cylinders were of such proportionate dimensions as to give approximately identical tractive force. Up to the end of 1899 the Chemin de Fer du Nord had 60 eight-wheeled express engines on this system, Nos. 2,121–2,180, virtually alike in main design, but built in five successive batches, each slightly in advance of its predecessor in respect of power—mainly in the department of boiler-capacity, the steam pressure also increasing from 199 to 213 lbs. per square inch. The P.L.M. acquired 40 of its own variety of these locomotives, Nos. C.21–C.60, subsequently adding 90 more considerably larger and more powerful, Nos. C.61–C.150. The Midi, Etat, Est, and Ouest lines all adopted the de Glehn type, which had been brought out by M. du Bousquet on the Chemin de Fer du Nord, differing only in minor detail, their initial numbers being respectively 1751, 2701, 2401, and 503. All these engines had four driving-wheels coupled, 6 ft. 7 in. to 7 ft. in diameter two high-pressure cylinders, placed outside, about 13 in. to 13½ in. diameter, and two low-pressure cylinders, placed inside, 20 in. to 21 in. in diameter, each cylinder having a 25½ in. piston stroke; the total heating surface was 1,500 to 2,000 square feet, and the steam pressure 199 to 213 lbs. per square inch.

A New Development.

Then the Chemin de Fer du Midi took a fresh departure. For certain of its services it needed an engine with greater haulage power—that is to say, tractive force multiplied by adhesion weight—than the four-coupled de Glehns possessed. Accordingly, M. Mofre designed a ten-wheeled locomotive, a compound on the de Glehn system, but with six coupled wheels of smaller diameter than those of the four-coupled type, viz., 5 ft. 8 in., and with slightly larger cylinders, the four-wheeled leading bogie being retained. These engines, No. 1301, etc., proved so valuable that after a preliminary trial of No. 1301 on the Chemin de Fer du Nord—when she achieved haulage feats previously undreamed of—M. du Bousquet adopted the type and gave a first order of no fewer than fifty for his railway. They were built by three different outside firms and number, 3,121–3,170, many more being subsequently built. Originally intended for fast goods or heavy excursion-passenger trains, they were soon found to be most efficient express engines also, less fast on the level and on falling grades than the eight-wheelers, but able to haul very heavy loads up considerable grades with surprising ease and swiftness. They were adopted also by the other French main lines, and a subclass came out on the P.L.M. and Midi lines, which obtained increased tractive force by further reduction of the driving-wheel diameter. These two main types with their minor class-differentiations thus became the almost exclusive features of modern French practice as regarded fast services, whether for passengers or for goods. The provisions for passenger stopping trains, suburban

services, slow goods and mineral traffic differed of course *toto coelo* and require to be dealt with quite separately. But the service of *grande vitesse* in both its branches calls manifestly for first attention.

Latest French De Glehn Atlantic.

But quite recently the du Bousquet-de Glehn "Atlantic" engine of the Chemin de Fer du Nord has itself undergone a fresh and remarkable development in respect of dimensions. On the instruction of M. Solacroup, the able Ingenieur en Chef du Matériel et de la Traction of the Chemin de Fer de Paris-Orléans, M. de Glehn constructed for that railway, at the Ateliers of the Société Alsacienne de Constructions Mécaniques, an engine, No. 3004, of truly colossal proportions not only dwarfing the Nord and Great Western engines of the same type, but exceeding in weight even the locomotive giants placed on the Caledonian Railway by Mr. J. F. McIntosh, Nos. 49 and 50, and on the North-Eastern by Mr. Wilson Worsell, No. 532. This new French mammoth closely follows the lines of the Great Western "Atlantic," "La France." But the Orléans, No. 3004, is larger everywhere excepting only as to its driving wheels, which are identical in size, being 6 ft. 8 in. in diameter. The other principal dimensions of No. 3004 are as follow:—

Boiler—			
Diameter	..	..	4 ft. 11½ in.
Steam pressure	..	..	228 lbs. per sq. ft.
Tubes (Serve)—			
Number	..	..	139
Length	..	..	17 ft. 4 in.
Diameter	..	..	3 in.
Heating surface—			
Tubes	..	..	2,420 sq. ft.
Firebox	..	..	180
Total	..	..	2,600 sq. ft.
Firegrate area	..	..	33 sq. ft.
Diameter of h.p. cylinders	..	..	14½ in.
Diameter of l.p. cylinders	..	..	23½ in.
Piston stroke	..	..	25½ in.
Diameter of coupled wheels	..	..	6 ft. 8 in.
Diameter of trailing wheels	..	..	5 ft.
Diameter of bogie wheels	..	..	3 ft. 2 in.
Weight of engine loaded	..	..	73 tons.
Weight on coupled wheels	..	..	36 tons.
Weight on trailing wheels	..	..	16 tons.
Weight on leading bogie	..	..	21 tons.

These fine engines will run the heavy fast expresses between Paris and Bordeaux which, when they clear the suburban obstacles that cluster near the French capital, are booked at an average inclusive rate of over 52 miles an hour, while the various stages between stops are booked at average start-to-stop speeds of 52 to 55½ miles an hour over a road which has long banks at 1 in 200 to 1 in 125, and with loads ranging from 200 to 300 tons behind the tender. These remarks do not apply to the still faster-timed "Sud Expresses" which are relatively light trains and are worked by the older and smaller engines, but which, being composed of International Sleeping Car Company's stock, are limited to a maximum speed of 100 kilometres or 62½ miles an hour, whereas the trains consisting of the company's own ordinary stock are allowed to attain 120 kilometres or 74½ miles an hour.

A Gigantic French 4-6-0.

But the newest express locomotive of the French Eastern Railway is in some respects still more unusual

in style. It has been designed by M. Salomon, the able Ingénieur en Chef du Matériel et de la Traction of the Chemin de Fer de l'Est, and built at the Ateliers of the Company at Epernay. It is a compound of the de Glehn type and is a larger development of the earlier 4-6-0 class—known as "Series 10"—in which the six-coupled wheels were 5 ft. 8 in. in diameter; the high pressure cylinders 13½ in. by 25½ in., and the low-pressure cylinders 21 in. by 25½ in. The special peculiarity of the new engine consists in the great size of its six-coupled wheels, these being no less than 6 ft. 10½ in. in diameter. These appear to be the largest six-coupled wheels ever employed in any locomotive outside the "freak" order. Many years ago six 8 ft. 3 in. wheels were given to an experimental locomotive—on the "Estrade" system, all the carrying-wheels of the engine, tender and train being of the same extraordinary size. That experiment was purely of the "freak" character—like the Thuille locomotive shown in the Paris Exhibition of 1900 which also had 8 ft. 3 in. coupled wheels—four-coupled however—but which was never accepted as "practical politics." The new Salomon-de Glehn engine of the Chemin de Fer de l'Est is, however, a strictly practical locomotive and should prove exceedingly useful, although the need of wheels of such large diameter may fairly be deemed open to question in view of what is daily accomplished with 6 ft. 6 in. wheels.

The New Giant and its Duty.

Two engines of this class have been constructed. Their duty will be to work the heavy expresses which carry the chief traffic between Paris (including the English share) on the one hand, and Switzerland and Italy on the other. The Anglo-French portion is worked on two stages between Paris and the frontier at Petit-Croix, the engines being changed midway, at Chaumont. The Paris-Calais stage is fairly easy, the ruling grades being not more than 1 in 200. But in the eastern length the Vosges Mountains have to be crossed by grades chiefly at 1 in 125 and this necessitates ample locomotive power on heavy trains booked at 48 to 50 miles an hour. Latterly, the earlier 4-6-0 engines with six-coupled 5 ft. 8 in. wheels have been much used on this stage, but their wheels were thought to be somewhat too small for the highest speeds, although similar engines with 5 ft. 8 in. wheels have long been doing a great deal of equally fast express duty on the Chemin de Fer du Nord. So the new locomotives have been given wheels actually 2 in. larger than those of the latest four-coupled compounds on the same railway; also larger to the same extent than the six-coupled wheels of Mr. Wilson Worsdell's similar (but non-compound) type on the English North-Eastern, Nos. 2111-2115, and than Mr. G. J. Churchward's "98" and "100" on the Great Western, while 4 in. bigger than the wheels of Mr. J. F. McIntosh's Caledonian "49" and "50." Judging from the experience of those British types, the new Est engines should be able to run trains of 300 tons and upward with ease at the highest speed officially permitted, viz., 75 miles an hour, and to climb the Vosges gradients of 1 in 125 at well over 40 miles an hour. M. Salomon is to be congratulated on his highly interesting new departure, the result of which will be closely watched in this country.

The Latest Departure.

The closing year of the nineteenth century, A.D. 1900, witnessed the latest departure in French locomotive practice in the introduction on the Chemin

de Fer du Nord by M. du Bousquet of the Atlantic design for express locomotives, the de Glehn system of compounding being, however, maintained in its entirety. The salient features of M. du Bousquet's new design consisted in reducing the driving-wheel diameter by practically 4 in., viz., from 7 ft. to 6 ft. 8 in., in taking full advantage of the scope offered by the addition of a trailing pair of carrying wheels behind the firebox, for extending the dimensions of the boiler and firebox longitudinally—thus increasing the heating surface to 2,300 square feet, in increasing the steam pressure to 228 lb., and in enlarging the low-pressure cylinders to 22 in. in diameter, while the two pairs of coupled drivers were placed close together in front of the firebox thus midway under the boiler length and with the shortest possible driving-wheel-base. In other words the now-famous Atlantic design of MM. du Bousquet and de Glehn was evolved and its earliest exponent, No. 2.641 started work in 1900, while the sister engine, No. 2.642, was on view in the Vincennes Annexe of the Paris Exhibition. The tale has already been told in these columns of PAGE'S MAGAZINE by the present writer how the brilliant successes of the new type led to its large multiplication on the railway of its introduction and to its adoption also on the French Midi line and finally to an engine of the same type being obtained from M. de Glehn for the Great Western Railway of England.

The Midland Compounds.

Not long ago a description was given in these columns of the new three-cylinder compounds, designed and built at Derby for the Midland Railway, by Mr. S. W. Johnson, the eminent Chief Mechanical Engineer of that line. Also some particulars were added of the fine work done under the writer's personal observation on the very severe section of the Midland line extending from Hellifield to Carlisle. It was mentioned subsequently that the two later members of this class, Nos. 2633 and 2634 were now working up to London with express trains. Some brief account of one of their performances under the writer's own observation, on this section of the Midland Railway, will probably be read with interest. No. 2634 was employed to take the 10.15 a.m. down Manchester Express from St. Pancras to Leicester. The load was extremely heavy. It was officially reckoned as "21 coaches," representing a total weight of fully 350 tons behind the tender. On the first stage, London to Bedford, the engine had to contend with long banks at 1 in 177, 1 in 176, etc. These she ascended readily at a minimum speed of 47.4 to 50 miles an hour. Bedford was reached in 53 minutes 33 seconds, start to stop, the distance being a few yards under 50 miles. The length of 19½ miles from Luton to the Bedford stop, mostly downhill, was run in the quick time of 17 minutes 7 seconds, a maximum speed of 80.3 miles an hour being attained down the 1 in 200. Starting afresh, the following run of 49½ miles to Leicester was done in 56 minutes 42 seconds start to stop, notwithstanding a delay of 1½ minute through a signal check outside. The net time from London to Leicester allowing for the stay at Bedford, the start and stop there, and the signal check already mentioned, was 105½ minutes for the 90 miles. The second stage includes three trying banks chiefly at 1 in 100 to 1 in 119, 1 in 132 and 1 in 110 to 1 in 160. The minimum rate up 1 in 119 was 40 miles an hour. Such work as this unmistakably "hall-marks" Mr. Johnson's new engines as of the right stamp for service with heavy and fast-timed trains.

C. ROUS-MARTEN.

main line of the proposed system would be a canal from Venice by Milan to Turin; another would connect Milan and Bologna, and a third Bologna and Venice. A navigable waterway would also be made from Venice to the Austrian frontier, for which purpose three existing rivers would be utilised.

The Albula Engadin Railway.

In a previous issue of PAGE'S MAGAZINE an article on the Albula Engadin Railway was illustrated with some photographic reproductions which gave an excellent idea of the difficulties which were encountered by the engineers responsible for the line. A paper on the subject contributed by Mr. H. Cox to one of the German technical societies includes plans and sections which further emphasise the difficult nature of the ground. One of these, showing the section from Bergün to Preda, with its characteristic loops, is here reproduced.

The most serious difficulties of the whole line were encountered on the Sils to Tiefenkasten section, which comprises the greatest number of tunnels and the largest viaducts. This section is 12.5 kilometres (7.8 miles) in length, of which 4,106 metres (2 miles 970 yards), or 33 per cent. are in tunnel, and it includes as many as twenty-seven viaducts having a total length of 1,300 metres (1,422 yards). The steepest gradient on this section is 25 millimetres per metre (1 in 40). The estimated cost was 275,000 francs per kilometre (£17,700 per mile). The actual cost of the first contract of 5.5 kilometres (3.4 miles) in length exceeded the estimated cost by 200,000 francs (£8,000) in round numbers, and there was a similar excess in the case of the fifth contract, which shows that, taken altogether, the estimates were comparatively accurate.

Mr. Cox mentions that in the construction of the Albula Tunnel a great quantity of water had to be dealt with at both ends. At the north end the water increased in the first kilometre until it reached a quantity of 75 litres (16.5 gallons) per second. At 1,006 metres (3,300 ft.), in April, 1900, it rose to 300 litres (66 gallons) per second, and then remained practically constant at 215 litres (47.3 gallons) per second until the middle of the tunnel was reached. The temperature of the water was only 6 deg. C. (43 deg. Fahr.). Brandt drills were used at both ends. The average progress at the north end with two drills was 90 metres (98.4 yards) per month, and at the south end with three drills 130 metres (142 yards) per month. As a general rule ten holes were drilled in any area of 7 square metres (75.35 sq. ft.), that is to say, the section of the heading. Each of these holes was 1.40 metre (4 ft. 7 in.) long, and contained a charge of 25 to 35 kilograms (55 to 77 lb.) of gelatine. Each drill had to be renewed after boring to a depth of 16 centimetres (6 1/8 in.). A junction was effected on the 29th May, 1902.

The Irrigation of the Nile Valley.

It is difficult to estimate the practical benefits that must accrue to Egypt from the great dams constructed across the Nile. Sir Benjamin Baker, speaking at York on a recent occasion, remarked that "By means of the Assouan reservoir the flow down the river was supplemented in June to the extent of 20,000,000 tons of water per day, which practically doubled the available supply at the most critical time for the irrigation of summer crops. Without this discharge of water great difficulty would have been experienced in saving the cotton crops. Their irrigation of rice, which had been prohibited in previous years, was again allowed, and land for planting the durah crop was irrigated a month earlier than had ever been the case

before. In Middle Egypt 170,000 acres of basin land had been converted for crops, and each year more would be taken in hand, up to a final total of about 350,000 acres in two years. This land increased in rental value £3 per acre and in actual value £30, while the cost of all drainage and irrigation works was only £4 per acre. The result was an annual increased rental of upwards of half a million sterling on these converted basin lands alone." There can be little doubt but that there are openings for further engineering enterprise in Egypt of a most important kind, more particularly in the development of the Sudan. Those who are interested in the subject cannot do better than peruse the article on the Irrigation of the Nile Valley which appears in another part of the Magazine.

Westinghouse Gas Engines and Motors.

The Power Gas Corporation, Ltd., has recently placed an order with the British Westinghouse Electric and Manufacturing Company, Ltd., for the supply of two 250-h.p. 3-cylinder single-acting Producer Gas Engines, solid coupled to direct current generators of equivalent power. The engines will be installed at Dudley Port. The same company is supplying two 25-h.p. direct-current motors to Messrs. R. Waygood and Co., the well-known lift manufacturers, for installation at one of the stations on the Midland Railway.

Oporto Drainage System.

Messrs. Hughes and Lancaster, of 47, Victoria-street, have been successful in securing in open competition a contract to provide the City of Oporto with a complete drainage system. The firm will be required to lay between 60 and 70 miles of drainage under Oporto, and to construct numerous large ejector stations, the separate system being adopted, in conjunction with Shone ejectors. The sewage will be automatically raised by compressed air, rendering the aid of gravitation unnecessary. Our Houses of Parliament are drained on this plan. Oporto has an estimated population of nearly 120,000.

New Destructor Plants.

The Horsfall Destructor Company, Ltd., of Leeds, have recently shipped two important Destructor Plants to South Africa, for the cities of Bloemfontein and Durban. Among the new Destructors upon which the company is at present engaged may be mentioned plants for Folkestone, Bromley, Chiswick, Swansea, Batley, Stourbridge and Gosport. Several of these destructors will furnish power for electric lighting, sewage pumping, etc., in addition to the sanitary disposal of refuse.

Sewage Disposal.

An instructive paper on sewerage and sewage disposal was read by Mr. C. T. Cuss at a recent meeting of the Junior Engineering Society. He concluded with references to the three reports of the last Royal Commission, an important point in which is the Commissioner's statement as to the inadequacy of existing laws. The protection of our rivers and their sources from pollution is stated to be a matter of such grave concern as to demand the creation of a Supreme River Authority, with a view to prevent the recurrence of such disasters as that at Maidstone. The paper was illustrated by diagrams and apparatus. Mr. Hamp, borough surveyor, congratulated Mr. Cuss on his very able paper, remarking that it was most difficult to make accurate allowances for the outfall of a sewer owing to sudden heavy rainfalls. He paid a tribute to the efficacy of automatic syphons, having found their use very satisfactory at Swindon.

LIQUID FUEL AND ITS POSSIBILITIES.

THE important experiments made by Sir Andrew Noble at Elswick, and the attention which is being given to the use of liquid fuel by the Naval Department of the United States, are bringing this question into greater prominence than ever, and Mr. William H. Booth's careful survey of the theory and practice of Liquid Fuel and its Combustion,* therefore makes its appearance at an opportune time.

The author remarks that the successful combustion of liquid hydrocarbon is but an extension of the principles necessary for bituminous or hydrocarbon coal. The difference is that coal is burned partly upon the grate, and air, to burn the hydrocarbon distillates cannot well be introduced from below, as it can with liquid fuel which is burned in a floating condition, and can be fed with air from below very easily. The difference is but one of degree, but with liquid fuel the fact that all the fuel is floating, and would produce a specially foul black smoke under the conditions in which coal is burned, has compelled the adoption of means that ought to be adopted with coal-fired furnaces. An effort has been made to connect two practices, for in the present state of liquid fuel supply it is more than probable that its use will be parallel with the use of coal, especially in dealing with the sudden and high load peaks of electric stations. Liquid fuel cannot be universal unless the supply increases to many times what it is at present, and this points to a good future for the mixed system of firing, oil and coal being burned together in the same furnace.

An interesting chapter is devoted to examples of liquid fuel carriers by rail and sea. The tank wagon by Messrs. W. R. Renshaw and Co., Ltd., shown in the accompanying illustration, is considered by the author to be the best for the transport of liquid fuel by rail. It has a capacity of 2,800 gallons of oil at a specific gravity of .82, and is one of ninety built for the Shell

Transport Company. The shell plates are made in one length, $1\frac{5}{8}$ in. thick, and the dished ends are $\frac{3}{8}$ in. thick. The manhole is provided with a screwed cover, thereby forming an air-tight joint. The outlet has a plug valve worked by a handwheel at the top of the tank inside the manhole, and to the stool in which this valve rests is connected a wrought-iron branch tee-piece giving two outlets, one on either side of the wagon. These have each a $2\frac{1}{2}$ in. gun-metal sluice valve, and the end of the pipe is covered by a gun-metal cap to protect the screw to which hose coupling may be attached for discharging the oil. The whole of the riveting is done by hydraulic and pneumatic machinery, and the tanks must be tested to 20 lb. per square inch pressure, and must be absolutely watertight before being passed. The steel underframe should be of exceptional strength, a special feature in the wagon illustrated being the method by which the sole bars are joined to the headstocks, both by flanging of the bars and by cover plates. The oil tank is attached by four side brackets to the framing, and is also supported at each end against the headstock by blocks of timber. There is a longitudinal stay plate between the two dished ends and a pair of diaphragm or swash plates to distribute surging stresses throughout the whole tank structure. Made of tough steel plate of boiler quality, such a tank should bear a good deal of rough usage or collision without failure.

The author is to be congratulated on producing a work of such completeness, and on rendering the subject so attractive. In Part I. will be found a careful exposition of theory and principles; Part II. presents selected practical applications of the use of oil fuel, while Part III. contains many valuable appendices, and there are about 120 excellent illustrations.

* "Liquid Fuel and its Combustion." By W. H. Booth. 24s. net Archibald Constable.



TANK WAGON, BY MESSRS. W. R. RENSHAW AND CO., LTD., FOR LIQUID FUEL TRANSPORT.

GUNS FOR COAST DEFENCE.



A KRUPP 12-IN. COAST DEFENCE GUN IN ROTATING TURRET.

The projectiles weigh from 771 lb. to 981 lb., and their initial velocity attains 3,038 foot seconds. The maximum range at 22 deg. of elevation is 21,872 yards, and at 45 deg. of elevation 27,340 yards. The turret is rotated and the gun loaded by hand power, but either electric or hydraulic power can be applied, if desired.



A 3-IN. 12-POUNDER LANDING EQUIPMENT BY MESSRS. VICKERS, SON AND MAXIM.

Weight of Gun, 4 cwt. 14 lb. ; ditto of Carriage, 7 cwt. 3 qr. 4 lb. ; ditto of Limber complete (with 30 rounds) 13 cwt. 6lb. ; Muzzle Velocity (foot seconds), 1,600 ; Weight of Projectile, 12½ lb.

The Limber consists of a steel frame, supported on the axle by brackets and springs. At the rear of the frame is a hook for attaching the gun carriage when travelling, and the front is fitted to receive the pole, which is attached to the axle by means of a bolt.

NOTES ON THE WESTPHALIAN COAL FIELD.

BY

DAVID A. LOUIS, F.I.C., M.Inst.M.E., M.A.I.M.E., F.C.S.

The present article covers the various systems of winding in vogue. The previous article described the geology of the district, methods of working the coal, and means of transport.—ED.

II.

IN some instances, as at Rhein-Elbe III., one of the most magnificently equipped pits in the district, special forms of pit frames have been introduced. The two shafts Rhein-Elbe I. and II. have been working the upper seams since 1861, and it was intended to use them to work the lower seams, but since improved methods had rendered some 25,000,000 tons of coal in the thinner and neglected upper seams available, it was decided to utilise the old shafts to work this out, and to sink a new shaft, with all new appliances, to work the lower beds in which there are seventeen workable seams, varying from 27½ in. to over 5 ft. in thickness, representing some 45,000,000 tons of coal on this single property. The new shaft, designed to draw 3,000 tons of coal a day from three levels, is 2,625 ft. deep, and about 18 ft. in diameter, is arranged for double winding, a main winding on the Koepe system for the deepest level, and a supplementary winding, with cylindrical drum to serve the two other levels; the supplementary winding is arranged at right angles to the main winding. The usual German design of frame was not considered equal to do this work, so the four-legged form, illustrated in fig. 5, has been adopted, which not alone suffices to carry the weight and resist the strain of winding, but also relieves the shaft walls from pressure. The frame is 98½ ft. high to the hubs of the pulley, is constructed of plate girders, to present less surface to oxidization, and is provided with a travelling crane above. The shaft housing, which is in two stories, is constructed within the main frame on an independent frame work. The total weight of this structure is well over 390 tons, and the loads it will have to bear are:—

In the Main Winding.

Cage complete ..	4½ tons.
8 tubs	2½ ..
8 loads	5 ..
875 yards of rope	10½ ..

In the Secondary Winding.

Cage complete ..	3½ tons.
4 tubs	1½ ..
8 loads	2½ ..
875 yards of rope	4½ ..

The weights, heights, and capacity of some pit-head gears at other collieries are given below:—

TABLE C.

Mine.	Height in feet.	Weight in tons.	Useful load in wagons of 10 cwt.
Monopol	87	73	8
Ewald & Minister Stein	105	93	12
Preussen	124	107	8
Kaiser Friedrich ..	144	155	8

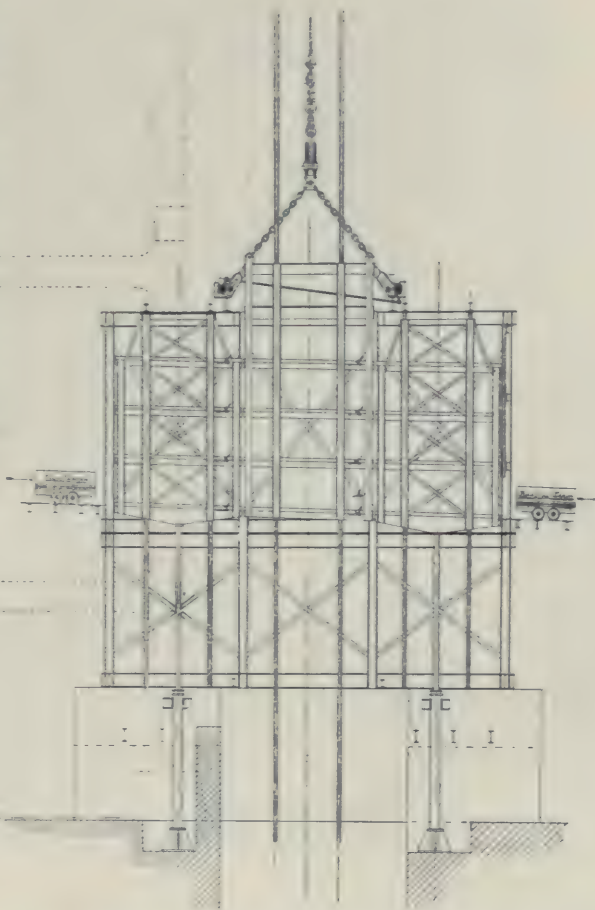


FIG 6. TOMPSON BANKING ARRANGEMENT—SIDE VIEW.

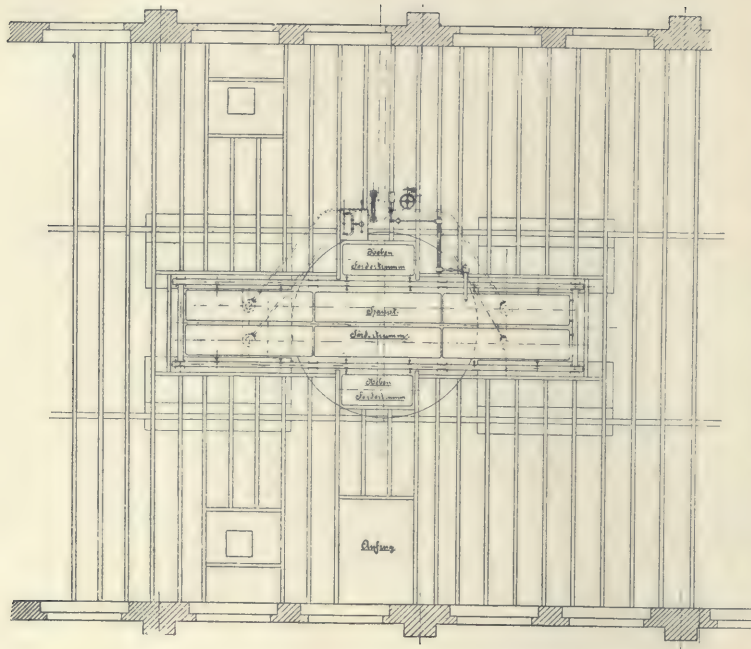


FIG. 7. TOMPSON BANKING ARRANGEMENT—PLAN.

All sorts of cages are in use, a great many carrying four tubs on two or four stages, some six tubs on three stages, others eight tubs on four stages, and a few even eight tubs on eight stages, but the most approved present practice is eight tubs, in couples, end to end on four stages. In some pits, Prosper II., Shamrock IV., for example, double winding is practised in a single shaft, which has the effect of greatly increasing the output, as much as 4,500 tons have been drawn in two eight-hour shifts, the best single winding has not given half that quantity. Some of the mines, only have a single landing-floor, others have several, but to avoid the inconvenience of multiplying landing-floors, and to save time, Tomson's banking arrangement has been introduced in some of the mines, and, so far, has worked well. It is a modification of Fowler's system, and an illustration of it was given on page 227 in the March issue of this magazine, but a word or two may now be said about it here. It consists of four auxiliary cages (figs. 6 and 7) each with as many decks as the main cage, resting on plungers in hydraulic cylinders two side by side on each side of the guide frame of the shaft, and installed at the surface and at the pit bottom. The decks are inclined, and the arrangement is such that when the main cage is in position for changing tubs, three cages are in line (fig. 6), one empty auxiliary cage in front ready to

receive the tubs, which run off the main cage as soon as the stops are released, whilst a full auxiliary cage behind, by the movement of a single lever, discharges its load into the main cage. Automatic stops on the main cage, operated by the tubs themselves, arrest their further progress. During the wind the auxiliary cages are charged and discharged. The two cages on the same side of the shaft are connected to one another by a chain passing over a pulley at the top, whilst the corner cages on opposite sides of the shaft are connected diagonally through the hydraulic cylinders. The full tubs are withdrawn from the lowest deck of one cage, while empty tubs are charged on the upper deck of the opposite corner cage; the hydraulic valve is opened and the superior weight of the full cage

in sinking, forces up the empty tub cage, but as soon as the next deck is at the level of the floor, the hydraulic valve is closed, the full tubs are withdrawn from their deck, and the empties charged on to the vacant deck of the other cage; these operations are repeated until all the decks are discharged or charged, and the loaded cage is in position behind the shaft, whilst the top deck of the cage just discharged is on a level with the floor and ready to receive its charge of empties. If the weight of the full tubs is not sufficient to raise the empties, an auxiliary hydraulic power is available. In the meantime, the overhead chain from the cage with the full cars has, during the descent of that cage, drawn up the empty cage alongside, so that there is a cage full of empties at the back and an empty cage in front of the shaft, both in position for immediate action as soon as the main cage is at rest on the automatic keps. At the pit bottom the operations are similar, but, of course, follow in the reverse order. The operations connected with the manipulation of wagons on four decks occupy less than a minute with three men at the surface, and four underground. In one pit, 1,720 ft. deep, the wind lasts 56 seconds, the changing 15 seconds, together 71 seconds, which, with 4³/₄ tons a time, represents about 220 tons of coal an hour. Figs. 6 and 7 show clearly this ingenious arrangement, with



FIG. 5. RHEIN-ELBE COLLIERY FRAME.

the hydraulic connections and the valve gear. Fig. 6 is a side view, and shows the opposite auxiliary cages in position. Fig. 7 is a plan indicating the order of the arrangement about the shaft which is represented by the large circle. The writer was much struck with the smooth and regular working of this arrangement.

The shafts in Westphalia, for reasons already stated, are very expensive, and therefore every effort is made to utilise them as much as possible. Double winding and the Tomson device are two modes of achieving this end. Another instance of a remarkable effort in this direction is that presented at Neumühl Colliery, when, in order to render the whole area of the upcast shaft available for ventilation and at the same time useful as a winding shaft, the entire shaft house has been constructed air-tight, presenting a total surface of 36,200 square feet to the outer atmosphere. This structure, illustrated in figs. 8, 9, 10, 11, and 12, encloses the whole banking floor and tipplers,

as well as the guide frame and winding pulleys, the only direct connections with the external atmosphere being the holes in the pulley casing through which the winding ropes pass. These holes being only slightly larger than the ropes are lined with wood, and occasion only an inconsiderable leakage. Admission to this pit top is only obtained through air-locks, all the ordinary banking operations are conducted within the area of reduced atmosphere, and no inconvenience is experienced; certainly, none was felt by the writer when inspecting the arrangements at Neumühl. The arrangements, too, are such that material can pass out, but no air can pass in. Round coal, when required dry, is tipped into a shaking screen (*b2*, in the figs.); the smaller pieces pass into an air-tight hopper (*E*, in the figs.), whilst the round coal passes into a drum with an opening above in the reduced atmosphere, and an outlet below in the outer atmosphere; within the drum, 8 sheet-iron blades are arranged radially on a central shaft, and fit air-tight at the casing of the drum (*h*, fig. 11); and there are always two of these blades at least, on each side of the openings, in contact with the casing. These blades revolve and carry with them the coal which has been tipped in, delivering it below on to the picking belt in the outer air. In the case when coal may be delivered wet, it is screened in the usual way, and then falls into a water tank, which extends both sides of, as well as below the walls of the building forming a water seal, as seen in fig. 10, *c*. The coal is picked out by a conveyor on to the picking belt. The coal, where separation is not desired, is tipped into bunkers closed by a door above

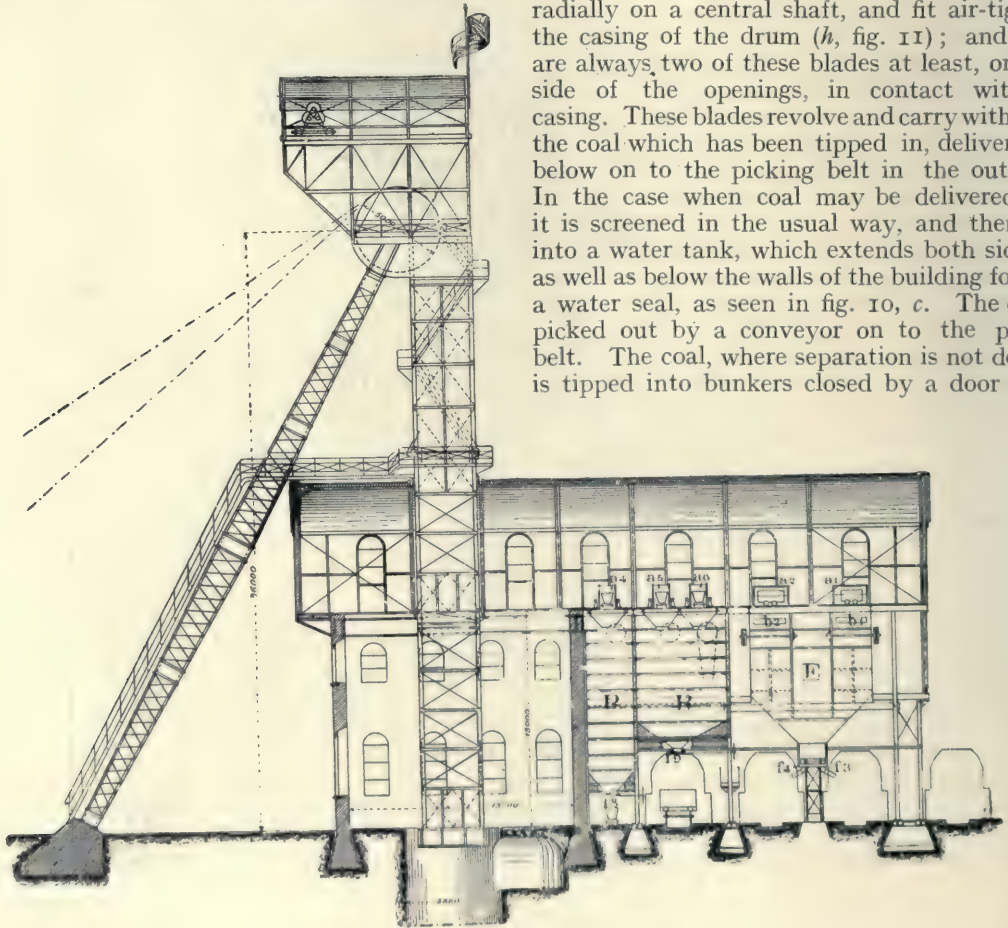


FIG. 8. PIT HEAD AT NEUMÜHL COLLIERY.

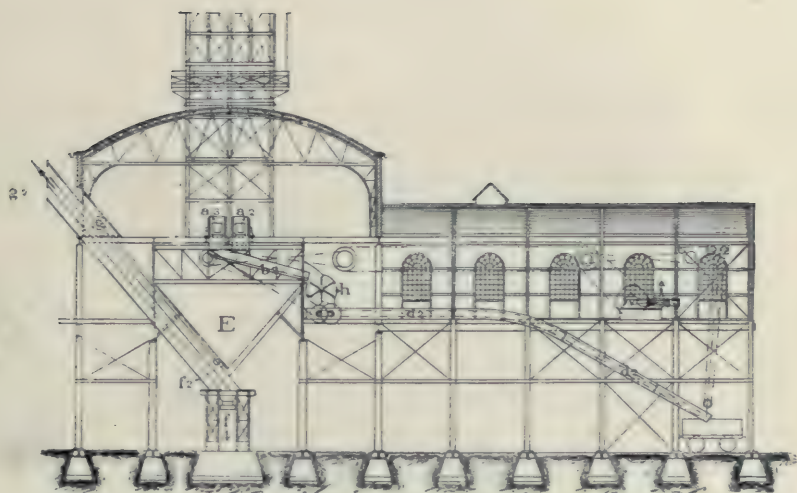


FIG. 11. SCREENING AND PICKING DRY COAL, NEUMÜHL COLLIERY.

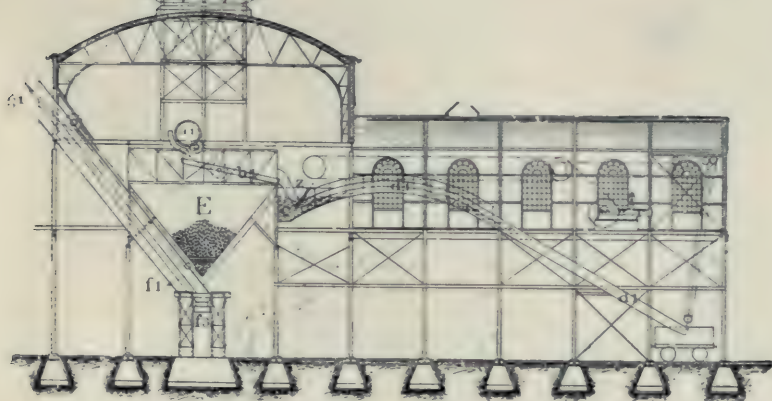


FIG. 10. SCREENING AND PICKING WET COAL AT NEUMÜHL COLLIERY.

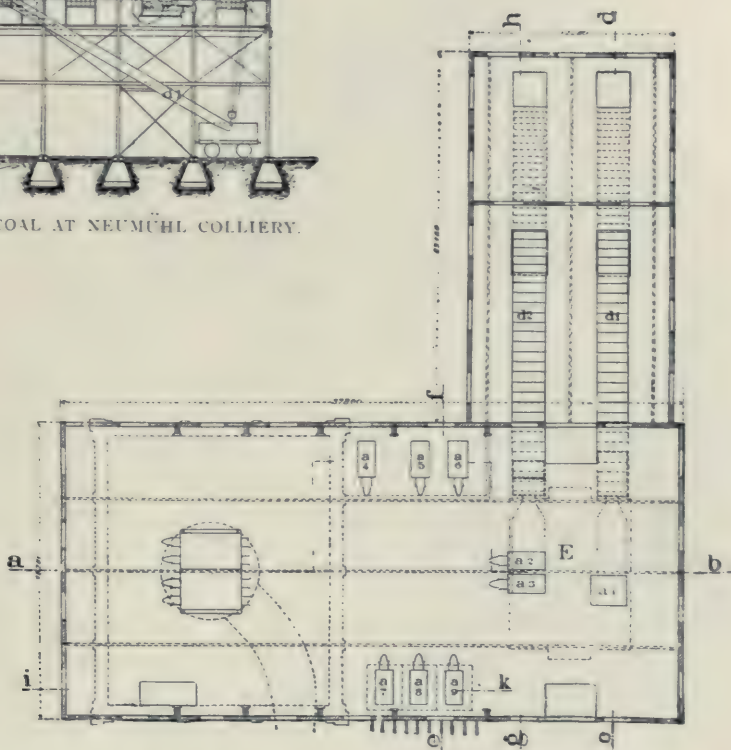


FIG. 9. PLAN OF PIT HEAD ARRANGEMENT AT NEUMÜHL COLLIERY.



SHAFT, SORTING AND WASHING BUILDINGS, NEUMÜHL COLLIERY.

and one below, which are never open at the same time (R, fig. 8), that is while the upper door is open no discharging takes place below, and *vice versa*. Waste is treated in the same way, being tipped into chambers which are really air-locks. There is a sufficient number of these chambers to obviate the necessity of opening the upper door while the lower or discharging door is open. The small coal hopper is also closed with doors, and, as indicated in fig. 11, there are arrangements for discharging the contents, and elevating them to the washery. It was very interesting to watch this arrangement working. All went smoothly and well, just as if the ordinary state of things obtained, although there was a current of 270,000 cubic feet a minute, and a depression of about $4\frac{1}{2}$ in. But, in spite of all, the leakage only amounted to well under 5,000 cubic feet.

Turning now to the actual winding, rail guides and round ropes are most in favour, whilst great diversity is observable in the engines and drums at the various mines, as might be expected in a field that has been in work a century. Twin engines, with narrow cylindrical drums of large diameter (5 ft. by 20 ft.) being the most common; compound engines are also in vogue, although it is not considered good practice in shallow shafts. Expansion is only slightly adopted in winding, and condensation not at all, except with central condensers, which are very much in demand just now in Westphalia. There are a few spiral drums to be seen, and Tomson's divided spiral drum is in use at the Preussen Collieries; this was illustrated in our issue of December, 1902, but fig. 13 is another view of this interesting winding engine, which, it will be remembered, will wind from three depths, 2,625 ft., 3,281 ft., and 3,937 ft., respectively, and that the useful load to be drawn from each depth will be 8 tubs, or 88 cwt. of coal, from the smallest depth; 6 tubs, or 66 cwt. of coal, from the intermediate stage; and 4 tubs, or 44 cwt. of coal, from the greatest depth; the maximum speed will be 72 ft. a second, and the mean speed 33 ft. to 40 ft. a second. The cylinders of the engine are $32\frac{3}{16}$ in. and $45\frac{1}{2}$ in. in diameter, and the stroke is $102\frac{3}{16}$ in. The drums are each 18 ft. diameter at the smaller end, 33 ft. at the larger, and $11\frac{1}{4}$ ft. in width.

But the style of winding engine most in favour is the twin-compound horizontal engine, with cylindrical drum, or sometimes, as at Scharnhorst, with spiral drum. The engines in this case are twin and tandem compound made by Friedrich Wilhelm, A.G., zu Mülheim a.d. Ruhr, with cylinders $27\frac{1}{2}$ in. and $37\frac{1}{2}$ in. respectively, and 63-in. stroke. The drum is 19 ft. in diameter at the smaller end, $26\frac{1}{4}$ ft. at the larger, and 5 ft. 11 in., with 150 lb. boiler pressure. These engines can wind a total load of $16\frac{1}{2}$ tons, including rope, etc., and a useful load of $4\frac{2}{3}$ tons from a depth of 1,988 ft., at an average speed of $32\frac{1}{2}$ ft. a second. The following numbers refer to a type of engine which is used and made by the Gutehoffnungshütte, A.V., of Oberhausen. It is also twin-tandem, and for a total load of 19 tons, including $7\frac{1}{2}$ useful to be wound at 1,800 ft. at a mean speed of 39 ft. per second, with a $17\frac{1}{2}$ -ft. cylinder drum, 11 ft. 10 in. wide, has the following chief dimensions: cylinders, 2 ft. $3\frac{1}{2}$ in. and 3 ft. $5\frac{3}{8}$ in.; stroke, 5 ft. 7 in.; and would work at a boiler pressure of about 160 lb. The Koepe system of winding is in good favour, and wherever introduced has given good results. The installations are mostly steam driven, but electricity has also been applied with

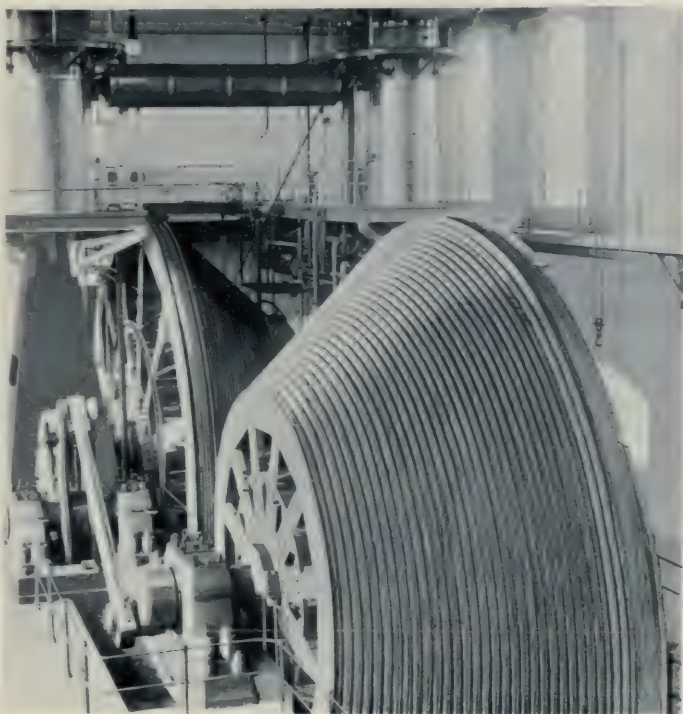


FIG 13. TOMPSON WINDING ENGINE AT THE PREUSSEN COLLIERIES.

success. Rhein-Elbe has a recent steam winding plant on Koepe system, made by Friedrich Wilhelms Hütte, Mülheim A.R., to wind a total load of $23\frac{3}{10}$ tons inclusive; $5\frac{3}{8}$ tons of coal from a depth of 2,625 ft., at a mean speed of $32\frac{1}{2}$ ft. per second. The engines are twin horizontal engines, with $25\frac{1}{2}$ -in. cylinders and 5-ft. 11-in. stroke, and work with 120 lb. steam. The winding engine at No. 1 shaft, Preussen II. Colliery of the Harpener Mining Company, of Dortmund, may be taken as an example of an electrically driven Koepe plant. The Koepe bobbin is $20\frac{1}{2}$ ft. in diameter, and the armature of the motor is keyed on to the same shaft. This was installed by the Allgemeine Electricitäts A.G. It is a three-phase engine; the current is supplied to the fixed portion of the dynamo at a voltage of 2,000, and is obtained from a central station, in which there are three three-phase generators, each of a capacity of 550 kilowatts when running 94 revolutions a minute. They are driven by an 800-h.p. twin-coupled horizontal engine.

There are also drum engines driven electrically, and there are, of course, other makers besides the Allgemeine Electricitäts A.G., and other types of electrically driven winding engines, but the one example must suffice here.

tons useful load at a speed of from 40 ft. to 60 ft. a second from a depth of 2,460 ft. Each valve box contains an admission, an exhaust and a relief valve. the latter intended to come into play when the pressure in the box gets too high and to return the steam to the supply system. There are also external safety valves, and they, as well as the spindles of the geared valves, which project through the covers of the valve boxes, are in the view of the engineman. These valve spindles connect with the gearing, which is operated by a special engine readily worked by the man with one hand. If required high-pressure steam can be admitted to the low-pressure cylinder; moreover, there is a control valve between the low-pressure cylinder and the receiver, and this and the throttle valve being connected can be worked by the same lever. The engineman hence has to watch and control the steam. There is an indicator to show the position of the cage in the shaft, which rings a bell when the cage is nearing the top, and puts on the steam brake in case of an overwind; there is a speed indicator connected with a clock-work tell-tale, which graphically records the speeds of each wind; this indicator, moreover, if the engineman neglects to slacken at the proper moment, applies the brake. Both indi-

TABLE D.

	Tons. Useful load.	Depth in fathoms.	Speed, ft. per sec.	Cylinders, diameter.	Stroke.	Drums. Measurements in feet.
Gutehoffnung—Horizontal twin-tandem...	$7\frac{3}{8}$	300	39	$27\frac{1}{2}$ and $41\frac{3}{8}$	67	$17\frac{1}{2}$ by $11\frac{1}{8}$; cylindrical
Preussen II.—Vertical compound	$4\frac{3}{8}$	438	33—40	$33\frac{1}{2}$ and $45\frac{1}{2}$	102 $\frac{1}{2}$	{ 18 and 33 by $11\frac{1}{8}$; Tomson's
" " "	$3\frac{1}{8}$	547				
" " "	$2\frac{1}{8}$	656				
" Three phase	$2\frac{1}{8}$	400	52	...	...	$19\frac{3}{8}$; Koepe
Tamarach—Four-cylinder diagonal	6	1,000	70	34	..	25; spiral

In Table D some data in connection with the Westphalian winding engines are given, and that of the Tamarach, in America, is cited for comparison.

GUTEHOFFNUNGSHÜTTE WINDING ENGINE.

The engine of this type, illustrated in the December number of PAGE'S MAGAZINE, is a horizontal twin-tandem engine. The high-pressure cylinders have a diameter of nearly $33\frac{1}{2}$ in., the low-pressure cylinders of $47\frac{1}{4}$ in., the stroke is $78\frac{1}{4}$ in.; the working steam pressure 8 atmospheres, and the duty to raise $4\frac{1}{2}$ metric

cators and their safety appliances are worked from the drums, and are independent of the steam supply gearing. The drums are cylindrical, with a diameter of about 28 ft., a width of above $6\frac{1}{2}$ ft., capable of accommodating 2,790 ft. of rope. They are provided with four brake blocks, which can be applied by hand or by steam, or as already noted automatically.

The cylinders, valve, boxes, etc., are lagged with non-conducting material and covered with burnished sheet metal. Most of the points noted can be seen in the illustration.

(To be continued.)



SUSPENDED RAILWAY TRIALS.

SPECIALLY CONSTRUCTED HIGH-SPEED EXPERIMENTAL CAR.

A BRIEF ACCOUNT OF THE HIGH-SPEED TRIALS ON THE BARMEN-ELBERFELD ELECTRIC SUSPENDED RAILWAY.

IN PAGE'S MAGAZINE some account was recently given of the Barmen-Elberfeld Electric Suspended Railway. At this time the whole of the line had not been opened, a certain portion being reserved for some high-speed trials. These have just been brought to a successful conclusion.

It is not intended to run the trains at speeds exceeding forty miles an hour, as the stations are too frequent. It may be noted, however, that Drs. C. Koepcke, A. Goering, and V. Borries, in a recent report on the Langen system, state that, if suspended railways were constructed above the existing ground railways for express passenger service, *speeds of up to 200 kilometres on curves of 500 metres, and of 135 kilometres on curves of 300 metres, could be attained.* During the past few weeks some very interesting high-speed trials have been carried out on the Barmen end of the line.

The trial car differs from those in ordinary service on this railway, the motor being placed above the roof, below the rail and supporting girders, both wheels of each bogie being drivers, for which bevel gearing is employed. This design permits of an arrangement of the car body and bogie trucks, so that their centres of gravity lie in a vertical plane passing through the rail, thus avoiding even the small oscillations which occur with the older type of car, due to the eccentric arrangement of the loads necessitated by the position of the motors. The wheels of

the new car are 2 ft. 6 in. in diameter, and each is driven by a continuous current series-wound motor of 50 ampères normal capacity at 600 volts. The bevel-gearing reduces the speed in the proportion of 1:2, and the motors are regulated by series parallel controllers. Two motors are sufficient to give the car a speed on the level of thirty-seven miles per hour, with a total current of 100 ampères at 480 volts at their terminals.

The speeds attained were calculated from the time taken to traverse a length of 200 metres, which was checked by a stop watch. In the presence of representatives of the German Government a mean speed of forty miles per hour was reached, and at a subsequent trial forty-four miles.

The above figures are those of the mean speeds, the maximum being greater owing to the length of line available for the trials being so short that the motors were still accelerating on the measured distance.

The maximum speed was attained with a total current of 170-580 volts at the motor terminals; according to the motor diagram, the speed was about forty-seven miles per hour.

The engineers reported that, with more powerful motors, and with a line designed for high speeds, there would be no difficulty in working at more than double the speed attained at these trials. The cars ran quietly and smoothly, and the passengers experienced no inconvenience.

SOME MODERN FIRE APPLIANCES.

ILLUSTRATIVE OF THE INTERNATIONAL FIRE EXHIBITION AT EARL'S COURT,
AND *À PROPOS* OF THE FIRE PREVENTION CONGRESS REPORT.

BY

GEORGE ARMISTEAD.

The previous article dealt with the work of the Fire Prevention Committee, and described some of the principal English-made Fire Appliances exhibited at the Earl's Court Exhibition. In the present article some of the principal foreign fire-engines and escapes are considered. Other English exhibits, electric fire-alarms, etc., will be dealt with in a subsequent article.—ED.

II.

A good deal of enterprise was shown by the foreign makers of fire-extinguishing appliances, whose exhibits greatly added to the interest of the Earl's Court Exhibition, and were, in not a few cases, found to merit the Exhibition Gold Medal.

The gas fire-engine of the Kuhlstein Wagenbau, shown in the accompanying illustrations, is fitted with everything necessary for extinguishing small outbreaks of fire. In the case of more serious outbreaks, it can be used pending the arrival of the steam fire-engine, the water-tank being ready for instant use, with a water store of 900 litres. The two steel cylinders under the water-tank, each with a capacity of 37.5 (37½) litres, are filled with compressed air, by means of which a pressure of eight atmospheres is brought to bear on the water-tank. In this way water can be thrown

to a height of 30 metres. In the immediate front part of the vehicle there is a seat for the driver, and behind it a *dos-a-dos* seat for the use of six firemen. Directly in front of the water-tank there is an iron-covered space with waterproof sailcloth at the sides. This contains four rolls of hose, and on each side one hose-reel with hose. On the top of this space is kept a "jumping-sheet," and on the left side a reel with hose for the life-saving apparatus. A box attached to the front part of the engine contains lists of the street hydrants. At the back lie the two large pressure leather pipes for the steam fire-engine, one on each side of the vehicle parallel to the water-tank. Under the water-tank an arrangement has been made for the storage of two hooks, three telescopic ladders, and two iron boxes. In one of the latter the smoke helmet



THE GAS FIRE-ENGINE OF THE KÜHLSTEIN WAGENBAU.



A FRONT VIEW OF THE ENGINE.

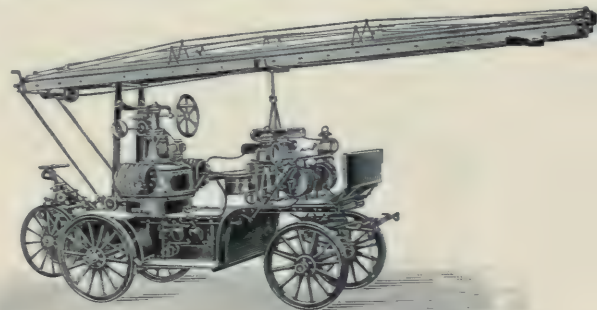
and the life-saving apparatus are stored. On the platform behind the water-tank are two seats for firemen. In the centre, under the vehicle there are two iron boxes which are filled with coal for the steam fire-engine. There is also an iron box on the front carriage between the two springs, which contains medicated bandages. The vehicle is almost entirely constructed of iron, steel and brass, and is fitted with patent mail axles.

The frame of the automobile fire-engine shown by the Waggon-und Maschinenfabrik A. G. of Bautzen, and here illustrated, consists of two lateral U-irons, which rest on long roller-springs, and are thus connected with the axles. The U-irons, which are braced up by cross-bands, carry as fixtures the tank, the motor, the pumping-plant, and the water and coal-tanks. The front water-tank is adapted as a seat for the fireman. The front axle consists of a quadrangular frame, which carries the components of the steering apparatus and which, in order to be able to steer the vehicle, can be moved horizontally round its centre of rotation. The four wheels of the vehicle have steel gun-carriage limbs and are fitted with india-rubber tyres. Steam is used as motive power for the propulsion of the vehicle and for the working of the pump. Provision is made for a boiler pressure of 3-4 atmospheres which can be kept up permanently at the station by a gas-heating apparatus, and within

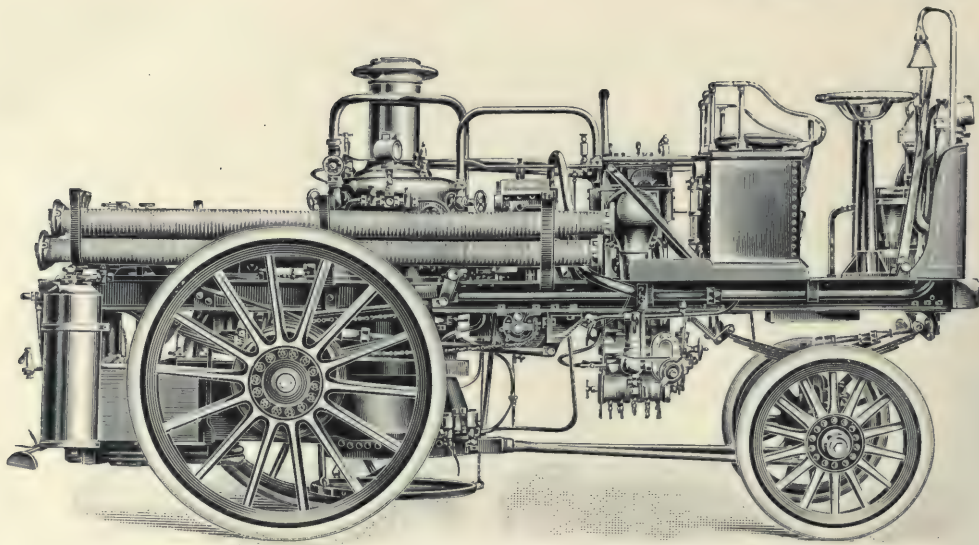
a few minutes from the start the pressure rises to the maximum of 10 atmospheres. The motor for the propulsion of the vehicle is a double cylinder engine with Stephenson's regulation. The transmission is effected by means of chains from the flywheel of the engine to the split pulleys over the hind axle. These pulleys carry cog-wheels on their outside, which grip the inside teeth of the hind wheels. The chains of the motor run outside the engine and inside the frame, so that a bearing could be fixed outside on the frame of the vehicle for the shaft of the flywheel. The chain-wheel on the left-hand side of the vehicle is fixed to the shafting by means of a wedge; the one on the right-hand side is connected with it through a peculiarly constructed sliding catch, so as to allow a different speed of the hind wheels in negotiating curves. The regulation of the engine, as well as the steering of the vehicle with the hand-wheel is carried out by one man, who acts as engineer as soon as the pump is set in motion. Apart from the brake power inherent to the engine, a double hand-brake for hand power is used, which makes an

almost instantaneous stoppage of the vehicle possible by the friction effected on the outside of the hind-wheel cog-wheels. The motor admits of a speed of about 28 kilometres on level ground; and at the various trials, inclines of from 12-14 deg. were taken. Six firemen can be carried together with engineer and stoker.

The engine can be fitted with a spirit-heating appliance, by which the spirit is conducted through spray nozzles from below, to the glowing material on the grate, and



GAS FIRE-ENGINE, WITH REVOLVING FIRE ESCAPE, BY THE NUREMBERG FIRE-EXTINGUISHING APPLIANCES AND ENGINE MANUFACTURING COMPANY, LTD.

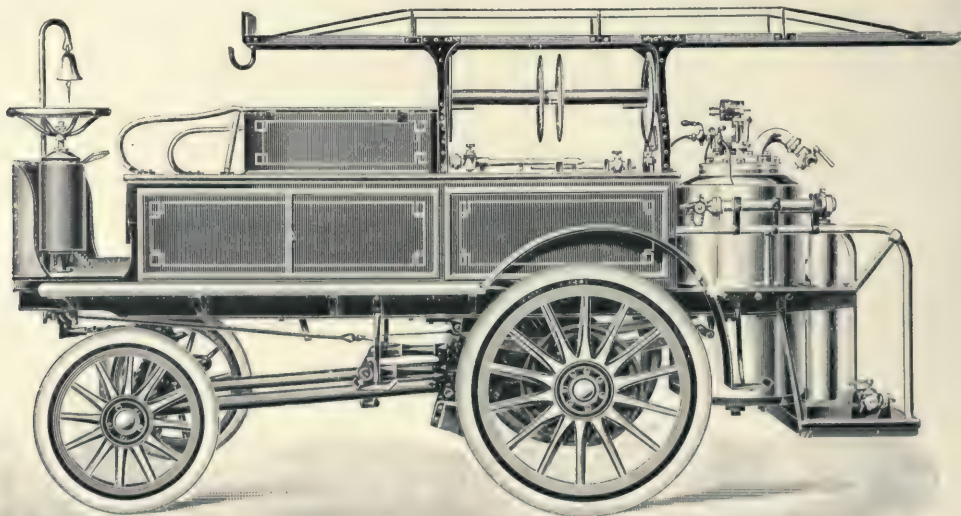


AUTOMOBILE FIRE-ENGINE, SHOWN BY THE WAGGON- UND MASCHINENFABRIK A.G. OF BAUTZEN.

which, when the fire-engine has arrived at the place of the outbreak, ignites at once the fuel used—i.e., coal or coke. Moreover, there are fixed two carbonic acid cylinders on the left of the fire-engine outside, which are connected with the boiler in such a way that safe and reliable action is ensured. The fire-engine can thus be started immediately upon the sounding of the alarm signal; while, in the meantime, the pressure necessary for the continuation of the journey is generated in the boiler.

The gas fire-engine of the Waggon- und Maschinenfabrik A.G. of Bautzen is designed for first aid in fire-extinction, and is also used for the transport of firemen and appliances. The water-tank has a

capacity of about 400 litres, and is tested to stand a pressure of eight atmospheres. The tank is fitted on the hind part of the vehicle between the two longitudinal beams. The battery of accumulators is to be found under the front and side seats. The space between the battery and water-tank is utilised for the storage of appliances; over this there is a hose-reel fixed for pressure-hose, and above it a ladder board for hook-ladders. The engine can be manned with eight men—three on the front seat, two on each of the two lateral seats, and one on the tailboard. The driver, who has to steer the vehicle and to regulate the speed, sits on the left-hand side of the front seat, whilst the warning bell is sounded by the man who occupies the middle seat, the officer in



GAS FIRE-ENGINE, MADE BY THE WAGGON- UND MASCHINENFABRIK A.G. OF BAUTZEN.

charge being stationed on the right. The vehicle is fitted with two motors, each of which drives separately a hind-wheel by means of simple cog-wheel transmission. The motors are constructed in such a way that, should one of them fail from any cause, the other one is capable of propelling the vehicle by itself. The lever to start the motors is fixed round the steering-shaft, and four different positions are provided for the forward motion, three electric brake-positions, and two positions for the reversed (backward) motion. The battery consists of 42 cells, which are contained in three wooden boxes. The highest speed of the vehicle is 18 kms. per hour. The consumption of current per km. covered by the vehicle including all losses, amounts to 0.8 kilowatt hours equal to 7.2 ampere hours with 110 volts. The time required for charging is therefore about $6\frac{1}{2}$ minutes per km. The charging current has a strength of 50 amperes. A charging tension of 110 volts is required. The wheels are fitted with india-rubber tyres.

The need for long ladders in fire-brigade work is self-evident. People living on the upper floors of large buildings are relatively more exposed to danger in case of an outbreak of fire than those living on lower floors; they have a much longer way to reach the bottom of the staircase, and are exposed to the smoke rising from below.

In order to interest the different manufacturers in the construction of high escapes, the Society of Arts offered a gold medal for the best long ladder of a height not less than 80 feet, exhibited at the International Fire Exhibition. Only four makers—all Germans—competed for this medal, and all exhibited turn-table escapes.

Thorough tests of the escapes were made on July 10th, the jury consisting of eleven professional men and engineers, with the result that the medal was awarded to Mr. C. D. Magirus, Ulm-on-Danube. These escapes, which are largely used on the Continent, have a four-wheeled carriage bearing a turn-table, upon which the ladder is so fixed that it can be turned horizontally, and inclined at any degree.

There is no doubt but that the turn-table escape system is a very convenient one where long ladders are wanted, but these high escapes are naturally rather heavy. A ladder of this description can only be carried on a four-wheeled carriage drawn by horses, and offering a good foundation for the escape when extended. It could not be carried on two wheels, nor could it be balanced by firemen. The escape is moved, turned, and inclined quite automatically by means of self-controlling mechanisms carried on the carriage.

The latter, when in use, remains always in a position parallel with the road, and thus causes a minimum of interference with the ordinary traffic. The extended Magirus Escape can be inclined to a projection of about 40 feet. Different windows can be reached by merely turning the appliance in the required direction. The escape can be carried for short distances with the ladder extended, and not more than four men are necessary to work it at any time.

Of the ladders tested one was made of steel-tubes, another wholly of wood, and two others—one of which was the Magirus Escape—were made of wood with steel



MAGIRUS PATENT TURN-TABLE FIRE ESCAPE, 83 FT.,
EXTENDED AND TURNED SIDEWAYS.

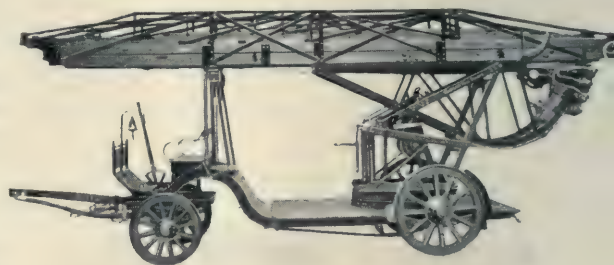
railings. These ladders are so rigid and substantial that they can be mounted freestanding, without the top touching the house, a feature which greatly increases their effectiveness. The escape, placed at a good position in the road, can be used as a water tower, and, in this case, of course, a man standing on the top of the escape carrying the hose is not so much exposed to the smoke and the dangers spreading from a house on fire. Besides this he is in many cases better able to direct the jet into the centre of the conflagration. The damage generally done by water—which is such a serious feature in outbreaks of fire—can also be materially reduced.

The escape can be raised and extended in a very short time; on the day of the trials, for instance, it took one man only 35 seconds to raise the escape and extend it 82 feet high, whilst two men raised the appliance, extended it 82 feet high, within 24 seconds. This rapid work is effected with the aid of a small double-cylinder engine, driven by carbonic acid, which is carried in large tubes on the escape. There is a patented arrangement which prevents the carbonic acid from becoming frozen. The same engine is used as a kind of brake in lowering the escape. The Magirus Escape can also be extended by hand.

An ingenious gas fire-engine, with revolving fire-escape, was shown by the Nuremberg Fire-Extinguishing Appliances and Engine Manufacturing Company, Limited.

This has been designed more especially to meet the needs of permanent or volunteer fire brigades in small or middle-sized towns, though it is, of course, equally suitable for general use. In this case the ladder attains a

maximum of 60 feet, and is easily attended by two men. The hose-reel carried on the engine is equipped with 650 feet of delivery hose, the tank holding about 120 gallons of water for immediate use; while, to afford the necessary pressure, carbonic acid is stored in four small steel cylinders. The engine, in addition to the firemen, carries a canvas jumping sheet, surgical box, smoke-helmet and apparatus, firemen's axes, torches, lamps, and lanterns. Above the tank is fixed the slide escape, which has a revolving movement, and is made up of three parts. It is claimed that this apparatus can be erected by two men in a minute, extended completely, pivoted 360 degrees, and inclined to the horizontal—the revolving is accomplished by hand.



MAGIRUS PATENT TURN-TABLE FIRE ESCAPE,
TRAVELLING POSITION.

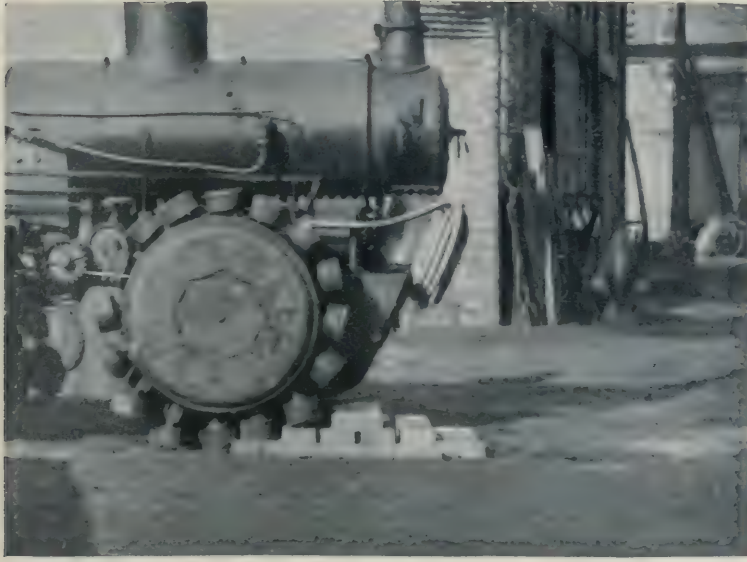
PROFESSOR HELE-SHAW ON THE PEDRAIL.

PROFESSOR HELE-SHAW, at a recent meeting of the Liverpool Self-Propelled Traffic Association, gave an interesting lecture, entitled "The Pedrail—a Revolution in Mechanical Locomotion." Mr. B. J. Diplock, the inventor of the Pedrail, was present.

In a previous issue of the Magazine we were able to illustrate this invention, and a further account of Professor Hele-Shaw's lecture may therefore be of interest.

Professor Hele-Shaw said a close study of road locomotion and the properties of the wheel for many years had convinced him that the wheel itself had reached its utmost limits of carrying power, both in regard to weight and speed upon the ordinary roads, however well constructed the roads or perfect the wheel. While the wheel would always play a most important part in road and railway locomotion—and he could not picture the possibility of any contrivance taking the place of the wheel and the pneumatic tire under suitable conditions—he was none the less compelled to believe that the mechanical

possibilities of engines and motive power, and the construction of the vehicles themselves, had completely outstripped that portion of the moving vehicle which was represented by the wheels. In great inventions the successful solution of a problem had often been found in imitation of the working of nature itself, as in the case of the screw propeller for ocean navigation. Could they say that there was in general use at the beginning of the twentieth century anything that could fairly be considered a means of locomotion on land imitating successfully the marvellous natural process of animal locomotion, but modified to suit the mechanical requirements of the case? He believed the pedrail to be the solution of that great problem. The pedrail was simply this: Instead of having a permanent rail carried for the whole of its length on sleepers, and wheels running upon this rail, the process was inverted. The feet, or sleepers, were placed upon the ground, but instead of the rails being carried upon the feet, the latter supported wheels which acted as bearers for a short length of rail attached to the moving carriage. The pedrail consisted of two



THE PEDRAIL MOUNTING AN OBSTACLE.

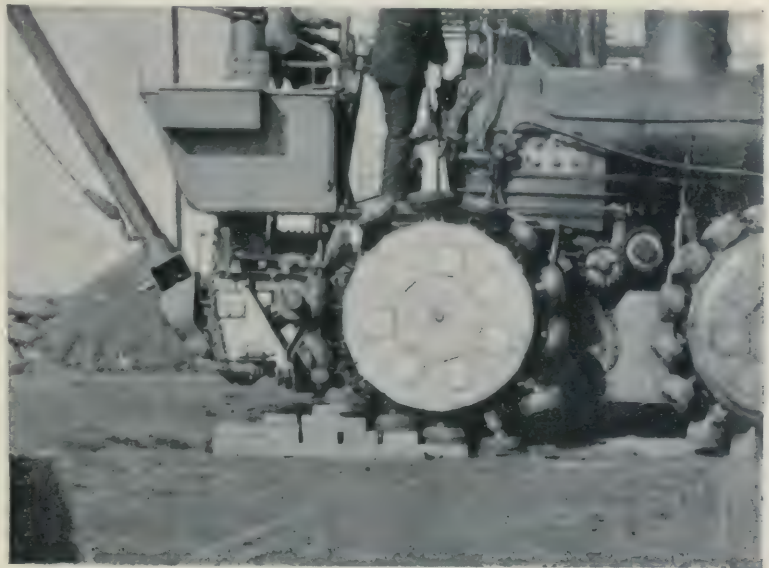
main parts: One was a railway fastened to the axle-box without revolution, and the other a kind of circular box carrying sliding spokes, rollers, and feet in such a manner that the rollers and feet were placed in succession on the ground and the rail ran over them. The Professor described the mechanism of the pedrail in detail, illustrating his remarks by exhibiting a small working model, and by cinematograph views of trials conducted by himself at Stoke. The views aptly hit off the Professor's description of the machine as "half traction engine, half elephant," the massive revolving feet in shape and action instantly recalling the movement of a large elephant. He proceeded to express the belief that the pedrail vehicle had passed from the stage of mere theory and initial experiment into the realisation of practice, and that the invention constituted a veritable revolution in road locomotion. The pedrail would climb the steepest hill, walk over large stones and such obstacles as nine balks of timber without damage, or pass over ruts and soft ground with the greatest ease. It could not sink into any hole that would stop the ordinary traction engine. After dilating upon the immense commercial and industrial possibilities opened up by what was the first successful

driver on four wheels yet made, and after commenting upon its economy of construction and the adaptability of the pedrail to ordinary traction engines, the Professor concluded by declaring that, in the interests of the progress of road locomotion the world over, they must wish the inventor that success of which there was every indication.

The action of the pedrail on the road was very remarkable. Whereas the ordinary traction engines destroyed roads to such an extent that they had been forbidden in many parts of this country and also in various parts of the world, and heavy motor wagons and traction engines had been severely taxed by local authorities and made to contribute to the repair of the roads, the pedrail positively improved the road over which it walked.

This had been proved by actual experiment, and it was more than probable, from the remarks of an eminent municipal engineer, that the pedrail was destined to entirely replace the road roller for repairing roads, as the action of stamping or ramming was much better than rolling for this purpose.

The lecture has been published by Messrs. William Clowes and Sons, Ltd., to whom we are indebted for the accompanying blocks.



STEPPING OFF.



ENGINEERING BUILDINGS A AND B AND PIERCE BUILDING—MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

FAMOUS TECHNICAL INSTITUTIONS.

The first of a series of illustrated articles, which will give brief descriptions of the most important technical institutions at home and abroad.—Ed.

I.—MASSACHUSETTS INSTITUTE OF TECHNOLOGY.

THE first technical institution dealt with by Professor W. E. Dalby, M.I.Mech.E., in his paper on the education of engineers in America, Germany and Switzerland, was the Massachusetts Institute of Technology of Boston, and in briefly reviewing the work of some of the most famous technical institutions of the world, we cannot do better than follow his example and start with the mechanical engineering department of this institution.

The course in mechanical engineering at the Massachusetts Institute is designed, according to its sponsors, to give to the student a thorough training in scientific principles in such a manner that he may be able, instead of relying upon rule-of-thumb methods, to apply these principles to the solution of practical problems. It aims not only to acquaint him with current engineering practice, but also so to develop the powers of his mind that he may be able, as occasions arise, to make improvements, and thus keep abreast with the progress of the times. As large a practical element as time will allow

is introduced into the recitation room, the drawing room, and the laboratory, the practical work being arranged to follow, and not to precede, the theoretical instruction bearing upon it.

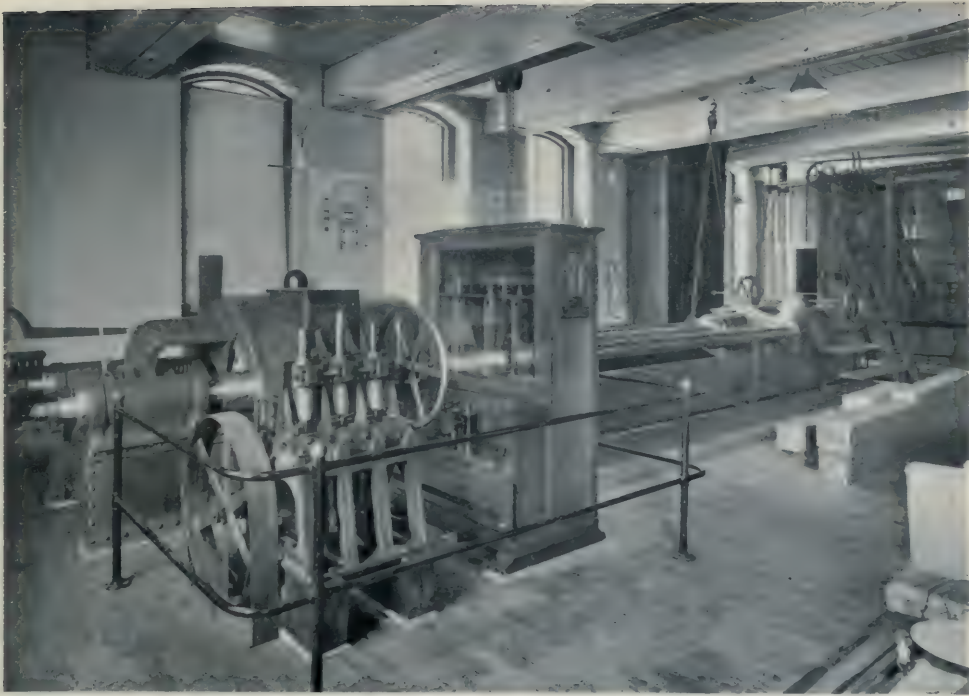
The students are required to perform tests in the engineering laboratories under the conditions of practice; and the apparatus and machinery employed are of practical proportions. They are not only drilled in accurate experimentation, but also carry on a considerable amount of valuable investigation.

A word of advice is offered to mechanical engineering students at the outset as to the vital necessity of a thorough grounding in mathematics, physics, and drawing (including descriptive geometry).

OUTLINE OF THE COURSE.

The course in mechanical engineering may be classified as follows:—

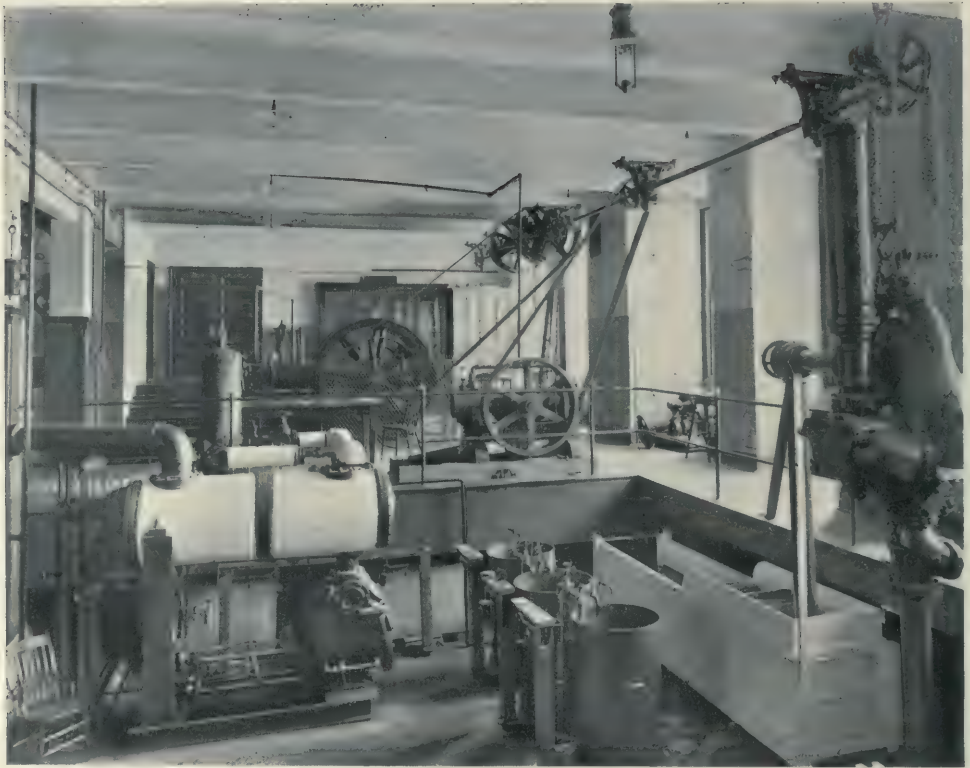
(a) Mathematics, physics (including technical electricity), and applied mechanics, given outside the department, the



IN THE MECHANICAL ENGINEERING LABORATORY—THE EMERY TESTING MACHINE IS OF 300,000 L.B. CAPACITY.



THE MACHINE TOOL LABORATORY.



ANOTHER VIEW OF THE MECHANICAL ENGINEERING LABORATORY.

last including the study of and practice in testing the strength of materials.

- (b) Class-room work of the department proper.
- (c) Drawing.
- (d) Engineering laboratory work.
- (e) Mechanic arts.
- (f) Visits to engineering works and manufacturing establishments.

The most fundamental subjects given outside the department are mathematics, physics, and applied mechanics.

As Professor Dalby pointed out, the course of instruction in America is very exactly laid down, the students being compelled to follow it step by step. "Slight variations are permitted in the form of options, to use their term, in the later periods of the course. But whatever option is taken, the student must go through with it. He gets his degree from the gradually accumulating results of terminal and sessional examinations, ending finally with a thesis. He is, in fact, put through a thoroughly well-organised species of educational drill, and must work or fall out."

SUMMARY OF THE COURSE.

The work of the first year is, of course, mainly introductory. The Second year's course comprises :—

(a) *Mechanism*.—The course includes a systematic study not only of the motions and forms of the various mechanisms occurring in machines, and the manner of supporting and guiding the parts, independently of their strength, but also of the design of gear-teeth, and the study of the mechanisms found in modern American machine-tools, and in cotton machinery.

(b) *Drawing*.—The students make working drawings of parts of machinery from measurements, and the drawings illustrating the class-room work in connection with the course in mechanism.

(c) *Mechanic Arts*.—Includes carpentry, pattern-making, and foundry work.

Third year :—

(a) *Applied Mechanics*.—This course extends through the third and fourth years. In the third year the subjects taught are statics, dynamics, strength of materials and graphic statics, in the order named. The calculus is freely employed throughout.

(b) *Valve-gears*.—This course includes the study of the different types of valve-gears, the design of simple and double valves by the use of the Zeuner diagram, the study

of the Stephenson link, and the working out of the same by the use of the skeleton model in the drawing room.

(c) *Steam Engineering*.—The course includes a thorough mathematical treatment of thermodynamics ; a discussion of the properties of gases and vapours, especially steam ; of the flow of gases and vapours ; of the injector ; of hot-air engines and gas-engines ; of steam-engines ; of air-compressors and compressed air machinery ; and of refrigerating machines ; besides which about one-half term is devoted to the study of steam-boilers, their details and accessories.

(d) *Drawing*.—The course in drawing aims to teach the proper way of making the necessary dimensioned drawings, tracings, and blue-prints for use in practice, good shop systems being adopted.

(e) *Dynamo-electric Machinery*.—This course includes a discussion in the lecture-room of the principal applications of electricity to the industrial arts, and in the laboratory of the most important general methods of commercial electrical testing of dynamo machinery, and the use of the instruments ordinarily employed in such testing.

(f) *Engineering Laboratory Work*.—This work is given during the second term, and is devoted to drill in steam-engine tests, for which the 9-in., 16-in., and 24-in. by 30-in. triple-expansion engine, and also the 11-in. and 19-in. by 15-in. tandem compound engine, are used. In these engine-tests the water consumption is determined by condensing and weighing the steam after it has passed through the engine.

(g) *Mechanic Arts*.—The instruction in mechanic arts of the third year includes forging and a portion of the chipping and filing.

Fourth year :—

In the fourth year the following studies are pursued by all students : Applied mechanics, machine design, steam engineering, engineering laboratory work, hydraulics and hydraulic motors, industrial management, dynamics of machines, and mechanic arts. The industrial management course involves a study of the organisation and relations of the various departments of an industrial establishment, both in the office and in the workshop, the conduct of accounts, the methods of compensating labour and of superintendence, and a careful study of the effect on cost of production of different systems of distributing indirect expenses.

Fourth year students are offered four options, of which one is required, *i.e.*, marine engineering, locomotive construction, mill engineering, and heating and ventilating.



THE FORGING LABORATORY.

THE ENGINEERING LABORATORIES.

The engineering laboratories for testing, hydraulics, and steam at Trinity Place, are very completely equipped, and occupy a floor space of about 21,000 square feet. The mechanical laboratories at Garrison Street afford the means of practical instruction in the nature of materials of construction, and in the typical operations involved in the arts. It may be mentioned that the carpentry, wood turning, and pattern-making laboratories employ some forty carpenters' benches, two circular-saw benches, a swing-saw, two jig-saws, a buzz-planer, thirty-six wood-lathes, a large pattern-makers' lathe, and thirty-six pattern-makers' benches. The founding laboratory has a cupola furnace for melting iron, two brass furnaces, a core oven, and thirty-two moulder's benches. In the forging laboratory are a power hammer, thirty-two forges, seven blacksmith's vices, a blacksmith's hand-drill, and power-shear. The

machine-tool laboratory contains twenty-three engine-lathes and seventeen hand-lathes, a twenty-four-inch turret lathe, two machine drills, three planers, a shaping machine, two universal milling machines furnished with spiral and gear-cutting attachments, a universal grinding machine, a cutter and reamer grinder, thirty-two vice benches arranged for instruction in vice work, a twenty-four-inch standard measuring machine, special apparatus for hardening and tempering, and a fully equipped tool room.

The accompanying illustrations, for which we are indebted to Mr. Harry W. Tyler, the secretary of the college, afford an excellent idea of the extent and completeness of these famous laboratories.

NAVAL ARCHITECTURE.

The course in naval architecture provided by the Institute, though relatively new, is already well grounded and established. Like all the courses at the Institute it gives in addition to a professional and technical training, a good scientific and liberal education.

The advantageous location of the Institute at an important sea-port, and near a navy yard, enables students to see ship and engine construction, and to visit ships of all types. This fact has made it possible to arrange for progressive speed-trials, tests of engine and boilers, and tests for locating the centre of gravity of a ship.

The department has a collection of complete sets of drawings of ships and their machinery, both merchant ships and warships, systematically arranged and catalogued, which, together with the proper data concerning construction, power and speed, makes it possible to proceed with the design and arrangements of ships as in actual practice.

There is a supply of planimeters and integrators which the students use freely, and a calculating machine with which they may become familiar. An optional course of lectures gives instruction in the use of slide-rules, calculating machines, etc.



ARCH-TESTING MACHINE IN THE MECHANICAL
ENGINEERING DEPARTMENT.

HANDLING HEAVY FREIGHT IN RAILWAY YARDS.

OUR illustration shows the latest type of an economical apparatus for handling heavy and bulky freight in railway yards. It includes a 40-ton Niles Overhead Electric Travelling Crane, 48 ft. span, and a substantial structural steel runway 40 ft. long. The crane spans three tracks, and leaves a wide passage way, which gives ample approach for teams and trucks on one side of the cars covered by this apparatus.

In addition to the main hook, a quick-running auxiliary hook of 5 tons capacity is provided for the rapid and efficient handling of light loads, which performs by far the greater part of the service of the crane.

The bridge consists of two heavy curved girders, of box section. It is driven longitudinally on the runway by motor located on the front girder, which is geared to the truck wheels; on either side, the motion being controlled by a foot brake in the operator's cage, which acts directly upon the armature shaft of the motor.

A foot bridge is provided the entire length of the span, with customary guard rail. The bridge trucks are of built-up type, securely fastened with the utmost rigidity to the girders, provided with heavy cast steel, double flanged

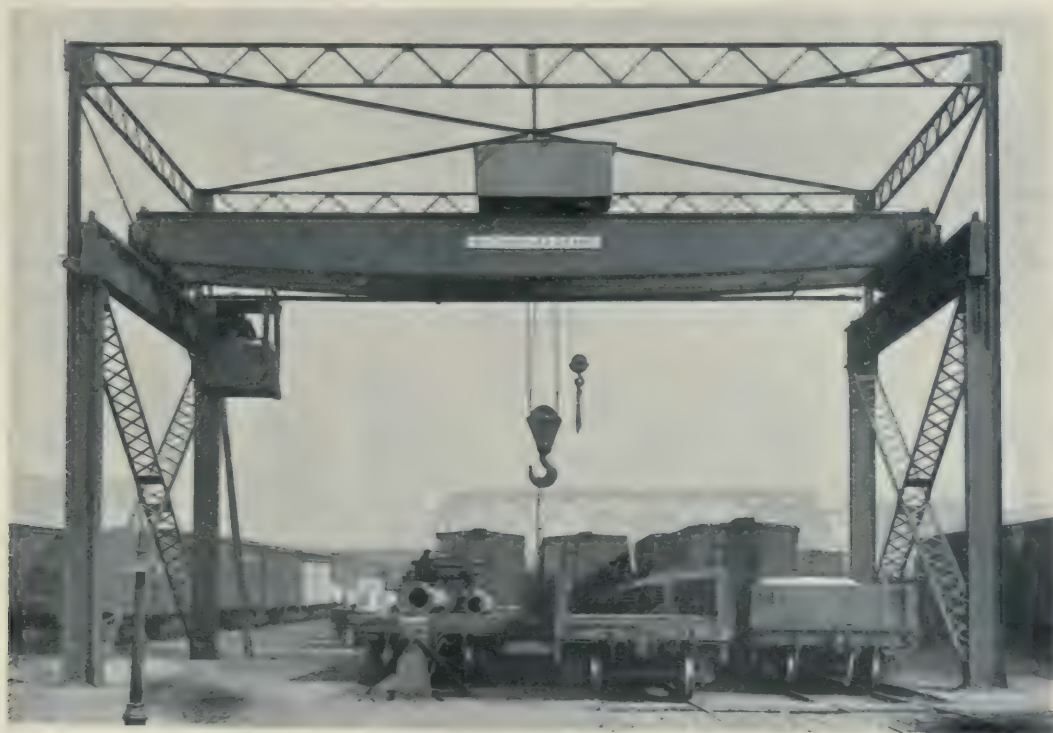
truck wheels with treads accurately finished to uniform diameter.

The trolley is the standard type used on overhead cranes, consisting of heavy side frames securely bolted together, and kept in perfect alignment by a separator. All the gearing is cut from the solid, and runs encased in oil, which gives the entire mechanism an unusually high mechanical efficiency.

Both hoists are provided with mechanical and electric brakes, also circuit breakers and limit switches to prevent overwinding and consequent damage to the crane or its load. The trolley, operator's cage, and bridge drive motor are of the inclosed type, affording suitable protection from the weather.

This crane is notable because of the extra height of lift, which enables the loaded hook to clear the top of box cars or other obstructions while performing the functions of its regular service of loading and unloading.

The complete apparatus was manufactured, installed, and erected by the Crane department of the Niles-Bement-Pond Company, Meadow and Mifflin Streets, Philadelphia, Pennsylvania. It is installed in the yard of the Buffalo and Alleghany Valley Division of the Pennsylvania Railroad Company.



40-TON NILES OVERHEAD ELECTRIC TRAVELLING CRANE.
Used for handling heavy railway freight.

NEW MACHINE TOOLS.

NEW GATE SAWING MACHINE.

Messrs. Edward G. Herbert, Ltd., have recently added to their line of metal sawing machines a new machine for sawing the "gits" off brass and other castings. The general idea of the machine is sufficiently explained by the illustration. The "git" to be cut is rested in the angle of the bar support, and the operator, who has both hands free to hold the castings, presses the foot lever by means of which the machine is started and the saw is fed through the "git." The feed of the saw is a gravity feed, which can be checked but not accelerated by the operator, who cannot jam the saw in the work. The saws are hard, of special make, and will cut the harder alloys of copper and also Delta metal and aluminium. With this machine "gits" can be rapidly cut off flush



GATE SAWING MACHINE BY MESSRS. EDWARD
G. HERBERT, LTD.

with the casting without fear of damaging the latter. "Gits" up to 1½ in. diameter can be dealt with at one cut, and larger sizes can be severed by two or more cuts. An important feature is that the saw stops running as soon as the treadle is released.

A DOUBLE HORIZONTAL PIPE FLANGE DRILLING MACHINE.

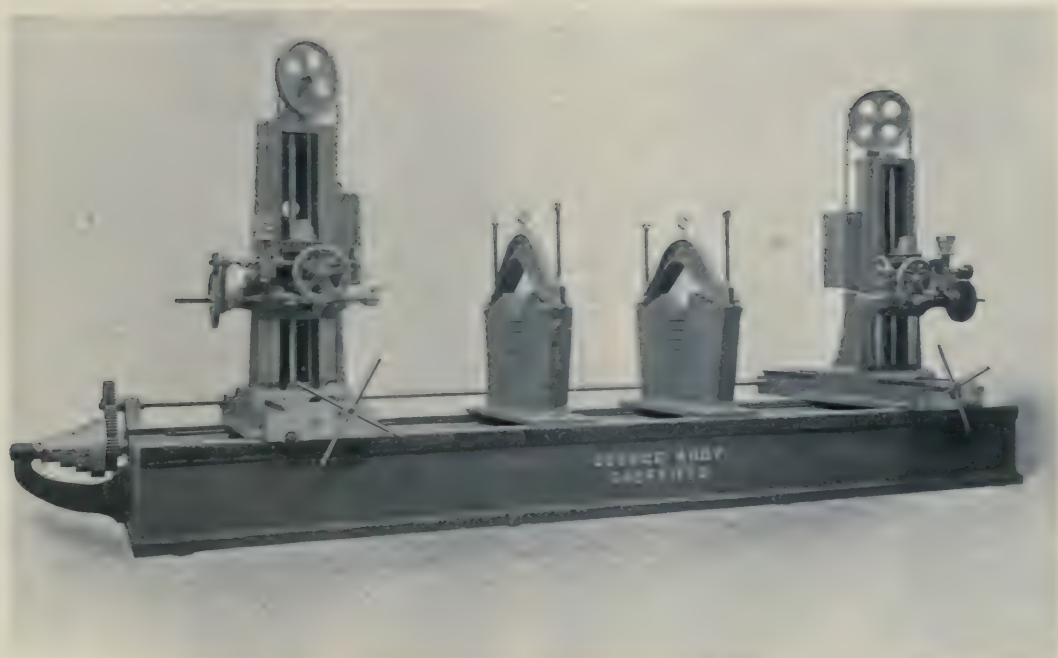
The wonderful economy of modern machine tools is well illustrated by Mr. George Addy's large double horizontal pipe flange drilling machine. This tool will take pipes up to 12 ft. in length, and 48 in. in diameter. Instead of each hole being dealt with singly, the pipe is simply dropped into the two cradles shown, fastened down, and kept in the one position until all the holes have been drilled. As both flanges are dealt with simultaneously, much time is saved, the economy resulting from the use of this tool, when compared with the old system, being estimated at 75 per cent. The bed, which is of box section, and of large dimensions, carries two uprights, each having a drill head provided with a forged steel spindle and self-acting variable feed motion. The drill heads can be moved into any position necessary for boring the bolt holes in the flanges of long or short pipes. The motions of the drill heads are entirely independent of each other, and can be run separately or together. Two large adjustable V blocks with portable top cramps are provided for holding the largest pipes, and loose V pieces are fitted therein to accommodate smaller pipes.

If desired, one or two loose adjustable tables can be supplied for holding bends and elbows, each having V blocks. These tables are bolted to the side of the bed in suitable T slots, and are pinched along the bed by means of a rack and pinch bar. The bevel gearing is amply protected by loose covers, and it will be noted that all movements are within easy access of the operator.

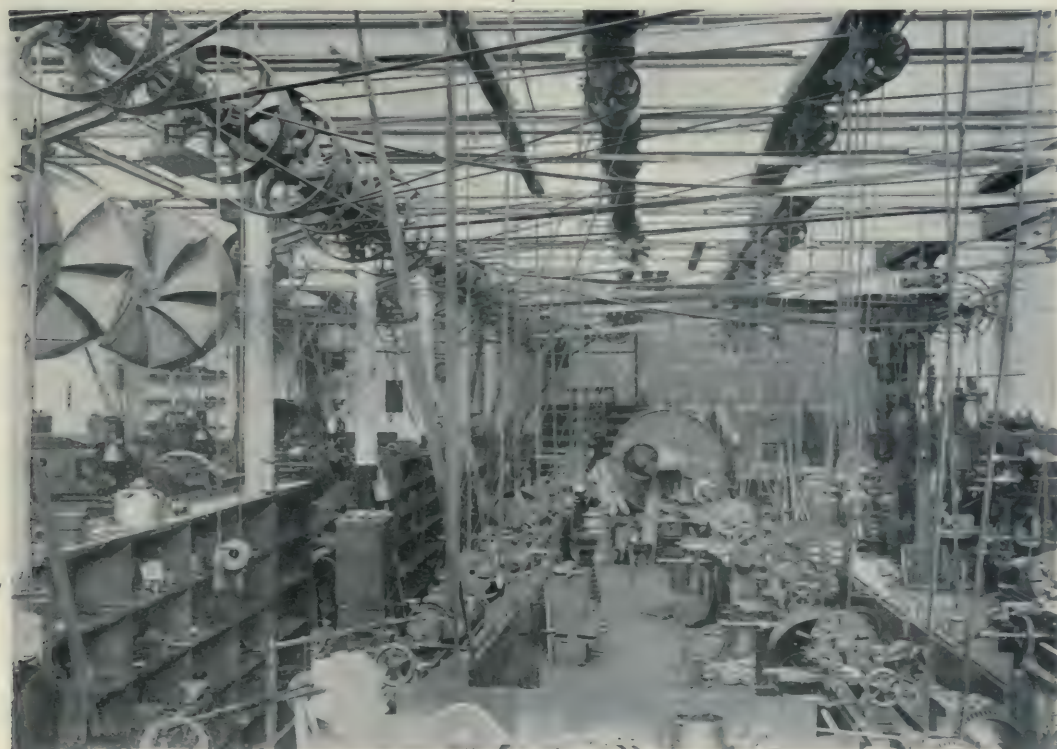
The machine is also useful for drilling the ordinary work in an engineer's workshop.

THE LIGHTING OF WORKSHOPS.

The accompanying illustration, showing the tool-room at the works of the James Keith and Blackman Company, Ltd., is presented as a good example of a well-lighted shop. There are no windows, but the roof is of the saw-tooth pattern, with 10-ft. spans, having a steep slope of glass in the north side of each ridge, and a longer slope of slate on the south side of each. The view is, of course, taken looking south.



DOUBLE HORIZONTAL PIPE FLANGE DRILLING MACHINE BY GEO. ADDY



TOOLROOM AT THE WORKS OF THE JAMES KEITH AND BLACKMAN COMPANY, LTD.

AUTOMOBILE DEVELOPMENTS.

THE Automobile Club announces trials for electrical vehicles to be held in May, 1904, but in the event of less than ten entries being received from this country, the trials will not be held.

Next year's Gordon-Bennett race will be held in the neighbourhood of Homburg, the German Automobile Club having decided upon a circular route, which will include, among others, the towns of Oberursel, Königstein, Limburg, Veilburg and Wehrheim.

The National and Stanley Shows were not remarkable for important new departures, though considerable progress was shown in the cheap motor vehicles for two passengers. At the Crystal Palace, probably the greatest novelty was the Kyma car, a two-seated three-wheeler of ingenious design. The Quadrant tri-car and the Raleighette were also noteworthy features. The principal novelties were in the direction of variable speed gears, and numerous devices for carrying a passenger as companion to the driver on motor cycles. There was a striking increase in the number of motor cycles shown. Machine tools were no longer an important feature at the Agricultural Hall.

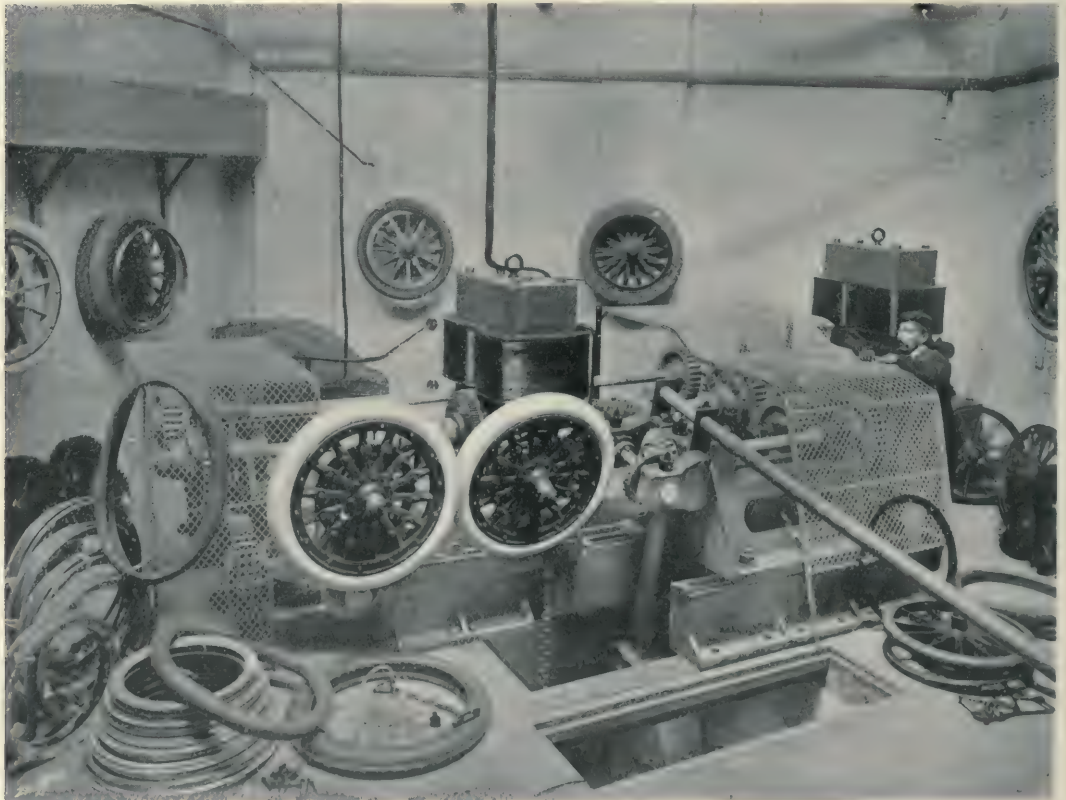
In the course of an excellent address on Modern Automobile Construction recently delivered to the

Junior Engineering Society, Mr. P. Warren Noble said that the Stanley Show this year had conclusively proved that English manufacturers were now capable of turning out cars equal to anything in the world.

Tyre Testing.

Our illustration shows the apparatus which is employed for tyre testing in the Experimental Department of the Palmer Tyre, Ltd. In order that the fabric of the tyre may be merely flattened at the tread where it is distorted under load, two pneumatic-tyred wheels are run together, both inflated to the same pressure. By this means each tyre forms the equivalent to a flat road for the other.

The wheel shown on the left-hand side of illustration (which may be termed wheel No. 1) is pressed against the wheel shown on the right-hand side by a lever carrying heavy weights which are in the pit below the apparatus. This represents the "load." The wheel shown on the right-hand side (which may be called No. 2) is arranged so that it may be turned upon a horizontal line at right angles to its axle in such a manner that when so turned it revolves in a different plane from wheel No. 1. In order to keep No. 2 wheel steady, its support is attached



TYRE-TESTING MACHINE IN THE EXPERIMENTAL DEPARTMENT OF THE PALMER TYRE, LTD.

to a heavy pendulum weighing upwards of 2 tons, which may be seen in the pit below the apparatus.

If this pendulum is caused to rock to and fro while the wheels are revolving, the strains which are set up in the fabric of the tyres are similar in character to those which take place in the fabric of motor-car tyres when driven rapidly round curves varying in direction.

Two 50 h.p. electric motors are employed, both of which may be used either as a motor or as a dynamo. Assuming that No. 1 wheel is driven by No. 1 motor, and that No. 2 motor is disconnected, the apparatus is then "running light," and if the pendulum is stationary in a vertical position, the conditions are then similar to those of tyres on a loaded car running on a level road, No. 1 being the driving and No. 2 the front wheel.

If No. 2 motor is connected as a dynamo, then the conditions at No. 1 wheel are similar to a loaded car going up a very steep hill, and the conditions at No. 2 wheel are like those of a loaded car going down a very steep hill with the brakes fully on.

By means of special apparatus on the electrical switch-board, it can be seen at a glance how much electrical horse-power is supplied to motor No. 1, and also how much is given out by motor No. 2 being run as a dynamo; and by making allowance for friction of the apparatus, an approximate estimate may be obtained of the power absorbed by the tyres, which is very useful in comparing different makes. A series of jets of air directed on the surface of the tyres makes the condition similar to those of a motor car travelling in the open air.

An Automobile Machine Shop.

A battery wagon just completed by the U.S. Long Distance Automobile Company, of Jersey City, N.J., and delivered to the War Department at Washington, is to all intents and purposes a travelling machine shop of automobile type. The machine as illustrated by *The Iron Trade Review*, weighs about five tons and is propelled by a 4-cylinder 24-h.p. gasolene engine. The front wheels are 48 in. in diameter and the rear wheels 56 in. in diameter, fitted with Firestone solid rubber tyres. The vehicle has four speed changes in the forward direction and there is a reversing gear. There is ample supply of shelves, drawers and compartments for the storage of tools and general appliances, and on top of the machine are placed the extra artillery wheels and poles for the hoist, etc. The machine shop has a lathe, grindstone, emery wheel, forge, anvil, and a dynamo for lighting purposes. The wagon is capable of travelling at a maximum speed of about 10 miles per hour with full equipment of tools, etc., and the quota of men.

The Motor Reliability Trials.

The 1,000 miles Trials of 1903 were carried out under the guidance of the experience gained from the 500 miles Trials held in Glasgow in 1901, and the 650 miles Trials in 1902; but owing to the greatly increased trustworthiness of cars, it was decided, moreover, to make the conditions so stringent that only those cars of superlative merit would get through with maximum marks.

Full details of the marks gained will be found in the "Automobile Club Journal," in which it is remarked that a vast amount of very valuable knowledge has been

gained during the Trials; for instance, marks were allotted in proportion to freedom from dust raising in order to encourage the manufacturers to pay attention to this point, and to afford an opportunity to the Judges for obtaining some accurate data as to the conditions governing the raising of dust.

A novel feature was the taking of the fuel consumption throughout the *whole* of the trials. In view of the certain early adoption of motor vehicles for the carriage of goods, in which cost of fuel will be an important feature, there is no doubt that it is of extreme value to encourage makers to pay much more attention than they have hitherto done in the past to this point. The marks were allotted on a basis of actual pence per ton mile.

Association for Motor Van and Wagon Users.

It has been decided to form an association for motor van and wagon users, as a section of the Motor Union. Its objects are as follows:—

(1) To represent the views of motor van and wagon users before the Local Government Boards; (2) To resist undue restrictions being placed upon the use of motor vans and wagons by local authorities; (3) to consider any claim for financial and legal assistance in respect of actions at law, either civil or criminal, in connection with the use of motor vans and wagons; (4) to inquire into the question of tare weight of motor vehicles and other questions connected with the users of mechanically-propelled vehicles for the carriage of goods, and to collect information respecting the use of motor vehicles likely to be of service to the members; (5) to originate and promote improvement in the law from time to time directly or indirectly affecting self-propelled vehicular and locomotive road traffic, and to support or oppose alterations in such law; (6) to popularise and assist the development of self-propelled vehicular and locomotive road traffic; (7) to give information and advice, and generally to protect and extend the rights and privileges of users of motor vans and wagons.

Side Slip Competition.

The Automobile Club announces a side-slip competition, which will be held next year. Particulars of devices to be submitted should be forwarded, with drawings, not later than February 29th, to the headquarters of the club.

In interpreting the results of tests, the design of car on which the device is tested as affecting side-slip will be considered. Consideration will also be given to the effect of the device upon the speed or resiliency of the tyres or power needed to drive it; to the effect upon the road; to the effect upon the life of the tyre; to the liability to dangerous derangement or fracture; and to the price. The cars will be submitted to a Preliminary Test, which will consist of a run on a greasy surface, made up of a twisting course, to be covered within a certain time. All cars entering for this trial must weigh at least fifteen hundredweight without passengers. The Preliminary Side-slip Trial will take place on a private road or track consisting of concrete, cement, wood, or some similar surface, covered with some slippery clayey material. Competitors whose devices may be considered worthy will then participate in the endurance test which will consist of a run of not less than five hundred miles.

COAL HOISTING AND HANDLING ABROAD.

THE steadily increasing bulk in which coal is conveyed by sea and rail, and stored for boiler service in high pockets at power stations and plants, has led to a demand for increased speed in the necessary hoisting and handling machinery.

Demurrage on steamships and cars is an item to be carefully avoided in economical management, and the large cargoes now shipped to terminals can only be handled with success by specially designed high-speed machinery. The problem is different from, and more difficult than, the familiar one of bulk unloading and storage of coal, ore, or similar materials on the ground level from vessels. The element of height materially affects the machinery design. With a single tower, hoisting to about 50 ft. above tide water, forty to sixty tons an hour was, until recently, the common speed, and ninety to one hundred tons was only attained with difficulty in exceptionally favourable circumstances.

RAPID UNLOADING AT LINCOLN WHARF POWER STATION.

The work demanded of coal hoisting towers and their machinery is of the hardest description, both from the unskilled nature of the labour employed, and the shocks to the machinery incidental to this service, and it changes constantly with the nature and size of the coal, which may vary from a soft pea variety contained in open wooden barges, to a hard foreign product in cubes, 2 ft. square, loaded in steel vessels with small hatches. A remarkable advance in rapid unloading was recently made by the C. W. Hunt Company, West New Brighton, N.Y., at the Lincoln Wharf Power Station of the Boston Elevated Railway Company, a run of mine bituminous coal being raised 90 ft. above the tide water from one hatch of a vessel and delivered to the storage pockets, cracked to mechanical stoking size, at the rate of three hundred and twenty tons per hour, by one tower. This is an advance of about two hundred per cent. upon the previous best, and marks an important mechanical engineering achievement.

To attain this end, the steam engines of fifty to one hundred combined horse power, in common use have been replaced by machinery of three hundred horse power, and the coal cracking machine attached to the tower, cracks to the proper dimensions for automatic stokers, before passing to the pocket the enormous quantity of coal—over five tons per minute—which is delivered to it from the hoisting machinery. The ordinary small steam shovel has been supplanted by an automatic one of two tons capacity at each lift.

The time occupied in raising two tons of coal from the hold of a vessel to the discharging hopper, nearly 200 ft. above, is only six seconds, while the round trip, involving the operations of lowering and moving the shovel out of the boom, opening the former, digging up two tons of coal, raising it to the level of the hopper



AUTOMATIC DUPLEX 2-TON SHOVEL, CAPABLE OF LIFTING OVER TWO TONS AT EACH DIGGING.

It deposits load in the pocket, 100 feet above the hopper, in six seconds.



COAL HOISTING TOWERS BUILT BY THE C. W. HUNT COMPANY FOR USE AT THE LINCOLN WHARF POWER STATION OF THE BOSTON ELEVATED RAILWAY COMPANY.

and discharging it therein, is frequently performed in twenty-two seconds.

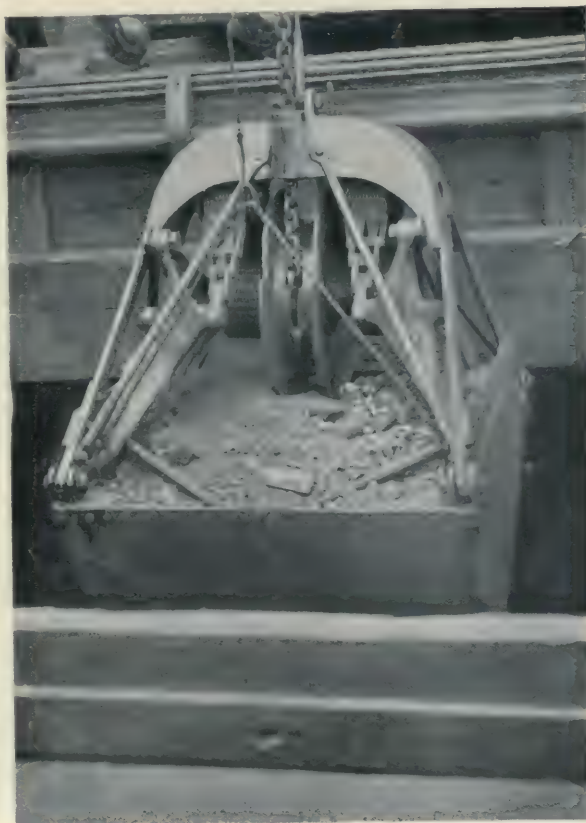
The installation, shown in the illustration, follows in general design, but in heavier proportion, the standard Hunt Steeple Tower Rig, the moving gear and coal cracker being electrically driven and the hoisting engine direct connected. The towers have to traverse overhead the whole length of the coal storage pocket and to move 30 ft. at a time without changing steam connection. In this way a single tower can operate on each hatch of a vessel in turn, or several towers can work simultaneously.

The boom, made to fold up, for the free manipulation of vessels with their rigging, has an overhang of 40 ft., and enables the tower to operate on coal steamers of the widest beam and largest dimensions.

NEW PLANT FOR DURBAN.

According to the *Colliery Guardian* there is a prospect of increased exports of Natal coal in the near future. The Government have recently restored the railway rebate on exported coal, and elaborate handling appliances are about to be erected at Durban and Delagoa Bay. The plant devised for Durban consists of two revolving tippers, capable of taking trucks of 40 tons or less capacity. In dumping, the coal is discharged into a large hopper underneath the wharf, and from it conveyed by a broad belt up an incline to storage bins specially constructed of steel, and with a total capacity of 6,000 tons, the space being divided into

compartments, each company so desiring to have the means of keeping its own coal apart from others. In drawing upon these stored reserves a second belt conveyor is employed which delivers the coal to the cross-conveyor by which it is carried to the ship, if necessary over a vessel lying "second off" the quay, and deposited through a patent chute or telescope, in bunker-hatch or hold. The capacity of the device is about 500 tons per hour, and by employing each of the three distributors provided for, 1,500 tons of coal can be handled in a single hour. An automatic machine for weighing the coal as it passes over the belt is part of the general arrangement. Coal can be also loaded direct from the trucks into the ship without passing through the storage compartments, and in such cases truck weights are taken. The plant has been designed to be operated by electricity, but steam may be used if desired. The amount of labour required to keep it running, if electrically equipped, has been estimated at two good mechanics and five labourers. Similar apparatus has been designed for Delagoa Bay, the cost involved in each case being estimated at £60,000.



ANOTHER VIEW OF THE SHOVEL DESCENDING INTO THE HATCH OF A VESSEL.

THE "BARTON" AIRSHIP.

DESCRIBED BY ITS INVENTOR.

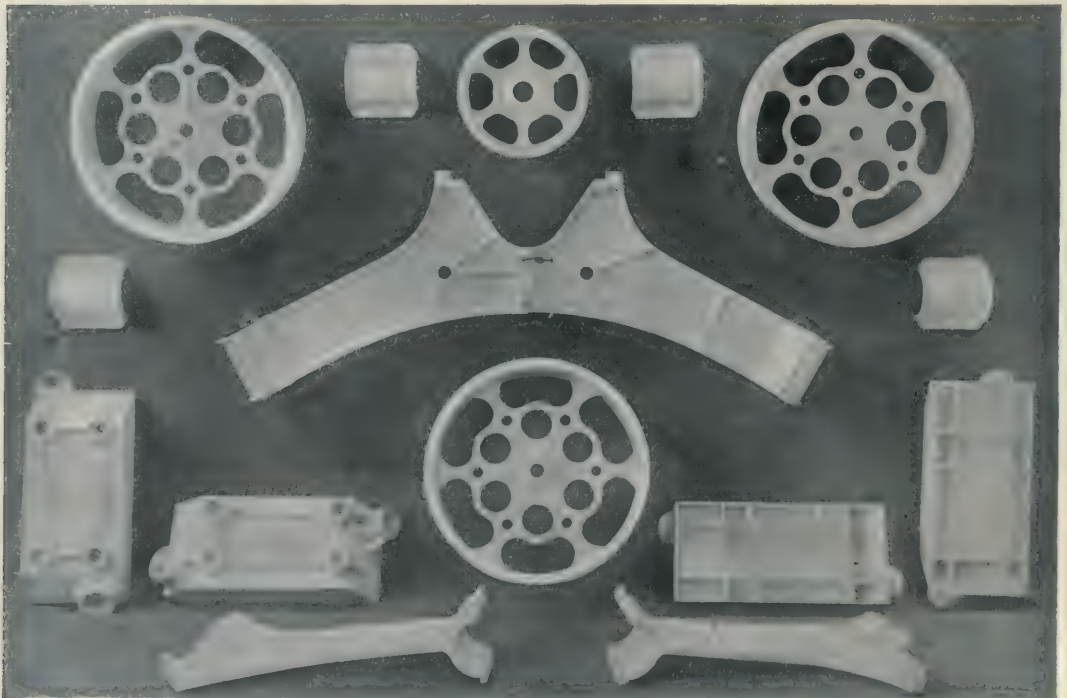
THE chief point in the "Barton" Airship is the introduction of movable aeroplanes between the cylindrical balloon and elongated car. The balloon is 180 ft. long and 42 ft. diameter, with a capacity of 230,000 cubic feet. The framework of the car is triangular in section, the apex pointing downwards to the keel. The base of the triangle is 16 ft. 6 in., the two sides being 24 ft. in length. The main structure is made of bamboo of an average diameter of 4 in. The deck consists of nine platforms joined by light bridges. The three main platforms, which are situated in the centre, bow and stern, are for the three 50-h.p. Buchet motors. These motors rest on two aluminium bridges. There is a third bridge of somewhat different form, placed parallel to the other bridge behind the motor. These bridges spring from the large bamboos which form the ribs of the car, and are joined longitudinally to one another by steel shafts.

The method of drive is as follows: clutch, pinion, two gear-wheels, two driving pulleys, Balata belt, two driving pulleys on propeller shaft. The pinion and gear-wheels are compressed Whitworth steel,

and the pulleys of aluminium designed by the "Unbreakable Pulley Company," and cast by Messrs. Mills and Co. They are fitted with phosphor bronze bushes. The propellers, designed by Mr. G. Walker, and manufactured by Messrs. G. Wailes and Co., of tubular steel and gun-metal unions, are six in number, and are placed laterally along the ship, one on each side of each motor.

The propeller shafts are carried in bearings in aluminium slipper plummer blocks. These blocks in their turn are carried on four steel tubes, the ends of which are received in sockets in aluminium caps. These caps, or boom-ends, also have sockets at the top and bottom for stout bamboos which are connected with the upper aeroplane frame, and the keel of the car, respectively, thus forming a pentagonal section round about the triangular section of the car.

The three engineers are in telegraphic communication with the helmsman by means of Bowden wires, and the same are used for throttling the engine and working the clutches. The aeroplanes are thirty in number, arranged in three series, one in front of each motor.



CASTINGS MADE BY MESSRS. W. MILLS AND CO. FOR DR. BARTON'S AIRSHIP

The framework in which these aeroplanes are held is of tubular steel, and gun-metal unions, manufactured by the Farrington Works and Pontifex, Ltd. Each series consists of ten aeroplanes, five on each side of the deck, and actuated by the engineers. Each aeroplane is 15 ft. wide, and 3 ft. long, the front edge being fixed, but the back is capable of being raised and lowered through an arc of 60 deg.

The raising and lowering of the airship is obtained by means of these movable aeroplanes, which obviate the necessity of letting out gas, or throwing out ballast, the only method hitherto adopted. Longitudinal stability is obtained by means of two water-tanks connected by pipes passing through a motor-driven pump. The tanks are situated at the bow and stern of the ship, and are capable of holding fifty gallons of water each. The airship is steered by means of a rudder 240 square feet in area. This rudder is on the partially balanced principle, the pivot on which it works being two-fifths from the front edge.

The motors are cooled by means of Clarkson's radiators, which are attached to the tubular steel booms behind each of the propellers. The estimate

of the total weight of the airship, crew, water, petrol, etc., is 15,700 lb.

The various castings made by Messrs. W. Mills and Co., for the airship, were as follows:—

No. of castings made.	Description.	Weight of each casting.	Dimensions.
6	Large pulleys ...	42 lb.	2 ft. 3 in. diameter by 7½ in. broad by 1½ in. bore.
6	Small pulleys ...	22 ..	1 ft. 3 in. diameter by 7½ in. broad by 2½ in. bore.
12	Boom ends ...	43 ..	2 ft. 6 in. by 1 ft. 1 in. by 10 in. over all.
6	Engine bridges (2 castings to each bridge)...	45 ..	
12	Keeps for ditto...	4½ ..	9 in. by 3 in.
6	Gear bridges ...	48½ ..	Ditto
6	Keeps for ditto...	4½ ..	Ditto

COMING EVENTS

January, 1904.

2nd.—Birmingham Association of Mechanical Engineers: President's Inaugural Address.

4th.—Institution of Mechanical Engineers: Graduates' Monthly Meeting.

5th.—Junior Engineering Society: General Meeting at Swindon.

7th.—Civil and Mechanical Engineers' Society: Meeting at Caxton Hall at 8 p.m.

11th.—Edinburgh University Chemical Society: General Meeting.

12th.—University of Liverpool Engineering Society: General Meeting.—Junior Engineering Society: Meeting at Swindon.—Institution of Civil Engineers: Ordinary Meeting.

13th.—Liverpool Engineering Society: General Meeting at the Royal Institution.

14th.—Birmingham University Engineering Society: Ordinary Meeting.—Institution of Electrical Engineers: General Meeting at the Institution of Civil Engineers.

15th.—City of London College Science Society: General Meeting.—Institution of Mechanical Engineers: Ordinary Meeting.

16th.—North-East Coast Institution of Engineers and Shipbuilders: Graduates' Meeting.—Manchester Association of Engineers: President's Inaugural Address.—Staffordshire Iron and Steel Institute General Meeting.

19th.—Institution of Civil Engineers: General Meeting at 8 p.m.

20th.—Liverpool Engineering Society: General Meeting at the Royal Institution.

21st.—Birmingham University Engineering Society: Ordinary Meeting.—Institution of Mining and Metallurgy: General Meeting.

22nd.—North-East Coast Institution of Engineers and Shipbuilders: General Meeting.—Junior Institution of Engineers: Presidential Address by J. Fletcher Moulton, Esq., K.C., M.P., F.R.S.

25th.—Society of Arts: Cantor Lecture.—Edinburgh University Chemical Society: General Meeting.

26th.—University of Liverpool Engineering Society: General Meeting.—Junior Engineering Society: Meeting at Swindon.

27th.—Liverpool Engineering Society: General Meeting

28th.—Leeds Association of Engineers: General Meeting.

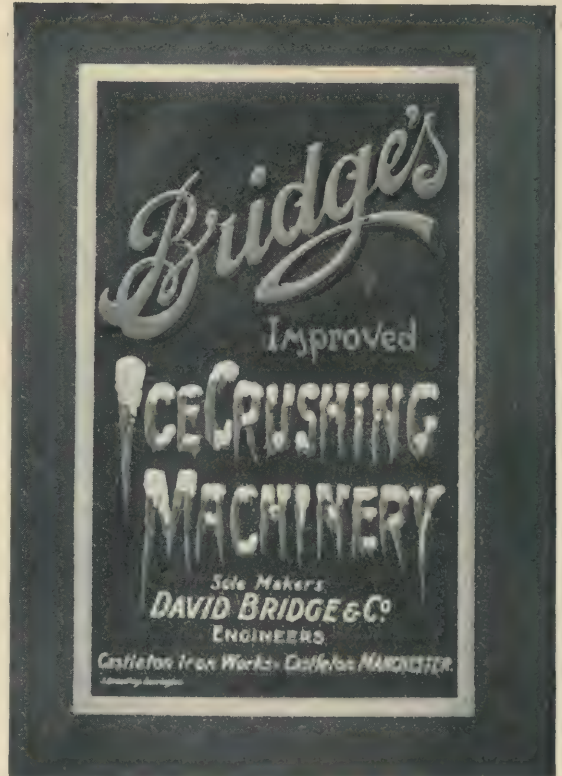
30th.—Manchester Association of Engineers: General Meeting.—Midland Counties Institution of Engineers: Joint Meeting at Sheffield.—Staffordshire Iron and Steel Institute: General Meeting.



CATALOGUE COVER DESIGN.



IN both these designs silver has been effectively introduced—in the case of Messrs. David Bridge and Co., to convey the suggestion of frost covering the words “Ice Crushing Machinery.” For this cover subdued colours have been chosen; dark green forms the background, while the centre panel, framed in silver, is of a chocolate tint. For the title a lighter shade of green has been employed, and the name “David Bridge and Co.,” etc., is executed in silver, the whole producing an appropriate and harmonious effect. The interior of the catalogue is attractively arranged, and it has been put together with a due regard to the value of time, the various tables, giving sizes and prices, being clearly set forth, and the whole catalogue provided with an index.



In the pamphlet dealing with Messrs. Samuel Denison and Son's Patent Testing Machine, the work of the artist is thrown into relief in silver. The name is displayed in black, the design being a thoroughly artistic conception, and reflecting much credit on the designer—Mr. Sanderson, of Leeds. The groundwork is of a brownish tint, and the hinges, represented on the outer edge, are shown in black. The small silver shield at the top bears the words “Engineering Employers' Federation, 1896.” The interior of the pamphlet consists of art sheets stapled together, and there are a number of excellent illustrations.

PAGE'S MAGAZINE

An Illustrated Technical Monthly, dealing with the Engineering, Electrical, Shipbuilding, Iron and Steel, Mining and Allied Industries.

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OUR MONTHLY SUMMARY.

LONDON, December 22nd, 1903.

Our New Battleships.

The purchase by the British Government of the two Chilean battleships, the *Libertad* and *Constitucion*, built respectively by Messrs. Vickers, Sons and Maxim and Sir W. G. Armstrong, Whitworth and Co., Ltd., appears to have given general satisfaction. For strategic reasons it would have been scarcely politic to have allowed these two powerful fighting ships to have been absorbed by a foreign navy, and they have been secured, moreover, at £1,875,000 instead of the £2,200,000 previously asked. It is generally known that a man-of-war is a compromise, and that there is a considerable divergence of opinion even among experts as to what constitutes an ideal battleship. These vessels having been designed outside the sphere of our control naturally embrace features which are not altogether in accordance with the views on construction which prevail at the Admiralty, and their acquisition will consequently necessitate the introduction of new ideas, the effects of which will be most carefully watched. They are powerfully armed—the *Libertad* has a complement of forty-six guns—and are well armoured, though their armour is not carried into the bows in accordance with the modern practice of the Admiralty. On the other hand the normal coal capacity is more circumscribed than is usual in our first-class battleships. The *Libertad* has exceptional accommodation for the comfort of the men. During her trials she showed her ability to steam at 17½ knots an hour with a coal consumption of 1·71 lb. per i.h.p., while at the full-power trials of six hours' duration the vessel ran six times over the measured mile on the Clyde, and developed a mean speed of 20·17 knots, with the engines running at 158 revolutions, the coal consumption being 1·73 lb. per i.h.p. per hour. Two warships are thus added to the navy at a reduced cost and ready for immediate action.

The Turbine in the United States.

The rapid development of turbine machinery in this country is likely to be well seconded in America. Elaborate tests of the leading turbine engines have been made by a specially appointed Board for the Bureau of Steam Engineering of the American Navy, and the conclusions of the Board have been embodied in two reports. It is strongly recommended that turbine engines be installed in one or two types of war vessels, for the purpose of conclusively determining their efficiency for general use in torpedo boats, destroyers, etc.

The first large set of steam turbines installed for screw propulsion in the United States being those of the steamer *Revolution*, it seemed appropriate to the Board to deal with the general performance of these turbines. They are of the Curtis two-stage, compound, marine type, reversible and condensing. Aside from the ordinary advantages claimed for the steam turbine, the most noticeable feature observed was the almost entire absence of vibration or disturbing noises usually attending the running of fast-moving reciprocating engines, and the slight care and attention needed while in operation. The turbine engines were

easily started, stopped and reversed, the time required for each operation being only that necessary for the opening and closing of a set of valves connecting the turbine casings with the main steam pipes. Five seconds was the maximum time consumed for the operation of reversing the motors from full speed ahead to full speed back, with two men handling the gear, one to each turbine. This may, however, be done by one man at a slightly increased expenditure of time.

Running full speed ahead with both screws, and then suddenly reversing the engines, the ship was brought to a standstill in about thirty-two seconds; the same conditions with one screw required about thirty-eight seconds. Similar operations were repeated with the vessel running at lower speeds, and about the same amount of time for reversing was required.

The trial of the Parsons engine was made with one 1,000-kilowatt steam turbine, built for the Cleveland Elyria and Western Railroad. It was of the two-stage type, direct connected to the revolving field of an alternating current generator, 400 volts, two-pole, three-phase, 3,000 alternations.

It was noted that the turbine ran without noise, the humming discernible being due to the generator. Its revolving parts, being accurately balanced, ran perfectly smooth, without even the slightest vibrations.

It is remarked that, compared with the reciprocating engine, there are fewer parts in the turbine that need watching, and a smaller engine-room force will, in all likelihood, therefore suffice.

The space occupied by a battleship engine of the usual stroke and piston speed is approximately 0.75 cubic foot per i.h.p. The space required for the turbine (bringing the cylinders close together and eliminating the generator) is about 0.68 cubic foot per i.h.p., the above being figured on a basis of efficiency of 0.85 in the reciprocating engine. The weights of the turbine may be cut down to some extent by substituting steel castings where now cast-iron is used—for instance, in bed plate and casing.

The Province of Wireless Telegraphy.

The extinction of the submarine cable services, which at one time might have been supposed to be imminent, seems hardly likely to be witnessed in our generation, but there is still a good deal of difference of opinion as to the province of wireless telegraphy. Sir J. Wolfe Barry, at the recent annual dinner of the Institution of Electrical Engineers, replying, on behalf of telegraph enterprises, said there were now no less than 225,000 miles of cable throughout the world, and considerably more than half were British. The capital held in this country in cable enterprise was £30,000,000, and the international messages with Great Britain numbered more than 100,000,000 words per annum, of which one-fifth were Government and Press messages. As to the possibilities of wireless telegraphy, he yielded to no one in his interest in that fascinating subject, but he would point out that the Eastern Telegraph Company had five cables from Cornwall, and at busy hours they dealt with 15,000 words per hour. There were forty cables which touched England, including the gigantic network of North American cables, and if other cables were working at the same rate they would arrive at a total of 120,000 words per hour, which was equal to 2,000 words or 12,000 letters per minute. Let them fancy this discharge of words being bombarded into ether and encountering there an equal bombardment from foreign countries. The prospect was appalling. The record of the cable enterprise since 1850, when the first little cable was laid across the

English Channel, and since about forty years ago, when the first cable was laid across the North Atlantic, was a great one, and when it was considered that these developments were brought about chiefly, if not entirely, by the enterprise of their own countrymen, the record was one of which they might well feel proud.

Nobody will be inclined to quarrel with these statements, but we hope that we may in time be equally proud of wireless telegraphy, which is likely to prove of incalculable service, in directions not necessarily opposed to the cable companies. An instance of its utility to the mariner was recently afforded by the accident to the American steamer *Kroonland*, en route for New York, which disabled her steering gear, about 130 miles west of the Fastnet, and had to put back to Queenstown.

The saloon passengers speak in the highest terms of praise of the utility of the Marconi wireless telegraphy with which the liner is fitted, and of the facility with which, when the accident occurred, the passengers were able to communicate with their friends in England, Scotland, and the Continent, and even America, and get replies before the Irish coast was sighted. The accident occurred in the middle of the day, and communication was at once made with the Marconi station at Crookhaven. Captain Doxrud was enabled accordingly to send messages to the chief agents of the American Line at Antwerp stating the nature of the damage to the steering gear of the steamer, and that he would have to abandon the idea of prosecuting the western voyage. Within an hour and a half a message was received by the captain from the agents instructing him what to do, and at once the *Kroonland* was headed for Queenstown. Three-fourths of the total number of the saloon passengers and a goodly number of the second cabin sent messages to their friends in various parts of the world, and replies were received even from the Continent before the Fastnet was sighted.

Life and Limb on American Railways.

The Interstate Commerce Commission has just issued its quarterly accident statistics for the period ending June 30th, 1903, and to quote a leading American journal, it certainly "cannot be said that they are in any sense gratifying."

"As for the totals—over 3,500 killed outright and nearly 46,000 injured, only the casualty records of the greatest battles in history will serve as a comparison."

The figures, as compared with the previous year, show a melancholy increase all along the line, though it is only fair to say that this is partly to be ascribed to the growth of traffic, and particularly to the presence in the service of an usually large proportion of inexperienced men, who have been employed, owing to the unprecented volume of traffic. The actual figures are as follows:—

	1903.		1902.	
	Killed.	Injured.	Killed.	Injured.
Passengers—				
In train accidents	164	4,424	167	3,586
Other causes	157	2,549	136	2,503
Total	321	6,973	303	6,089
Employees—				
In train accidents	895	6,440	697	5,046
In coupling accidents	253	2,788	143	2,113
Overhead obstruction, etc.	93	992	104	1,070
Falling from cars, etc.	678	8,025	537	6,867
Other causes	1,314	20,759	1,035	18,615
Total	3,233	39,004	2,516	33,711
Grand total	3,554	45,977	2,819	39,800

It is shown that only one in three of those killed, and about one in four of those injured, were in train accidents. Falling from moving trains or casualties while getting on or off, is the most frequent cause of death to both passengers and employees in the States. During the year under review, both collisions and derailments increased in number greatly as compared with 1902.

A Blue-Book has been issued containing returns of accidents and casualties as reported to the Board of Trade by the several railway companies in the United Kingdom during the six months ended June 30th, 1903, together with reports of the, inspecting officers, assistant inspecting officers, and sub-inspectors of the Railway Department to the Board of Trade upon certain accidents which were inquired into. Accidents to trains, rolling stock, permanent way, etc., caused the death of four persons and injury to 368 persons. The total number of personal accidents reported to the Board of Trade by the several companies during the six months amounted to 607 persons killed and 8,683 injured.

The New Imperial College of Technology.

The annual dinner of the Institution of Mining and Metallurgy, afforded the President of that Institution (Mr. Henning Jennings) an opportunity of dealing with the technical education question, and of showing the part which that institution has taken and is taking in connection with the movement. Explaining the circumstances under which the Council are centring their advice and aid upon the Royal School of Mines, he said they felt that the work of reorganisation should not be done on a little patch-work system, but on great broad lines, and thus they had welcomed the great scheme now on foot for the organisation of a great new Imperial College of Technology at South Kensington. They felt satisfied that if such a scheme were established, the claims of the strengthened and perfected Royal School of Mines for recognition could not be ignored, and that it would not be blotted out, but only strengthened and vivified. They also realise that at the present time the organisers of the larger scheme could not be assisted by detailed discussion or advice from them, as it was evident that the first step to be taken was to properly arrange the managerial and financial lines with the Government donors, and the amalgamated educational institutions. They understood that, when this organisation was complete, detailed technical advice would be eagerly sought, from all other professional societies which the various branches of the new college might embrace. Thus they felt that the most efficient way in which they could help forward this great, good cause at present was by having faith and patience.

In the same way public subscriptions to the Bessemer Memorial had not yet been energetically solicited, as it was not considered well to do so until the main lines of the larger scheme with which it was combined had been more defined. The interest in the movement, though at present allowed to lie dormant, was still intense and vital, and that institution had shown its belief in the final outcome of the scheme by promising from its funds an appropriation of one thousand guineas.

He would in no way attempt to set forth the relative statistics connected with the technical education of Germany, the United States, and this country. This had already been done by abler voices and pens than his. The point, however, that he desired to emphasise regarding these statistics was this: that by creating one great technical centre for higher

education in this country, they need not fear that they should be overdoing the business in comparison with other countries; in fact, in the case of the London Polytechnic schools, which had done and were doing such great good work for the artisan classes by their wonderfully efficient night school courses, the highest courses in this new college should only be regarded as a goal and prize for their best talent, and thus stimulate and not injure. Other existing technical institutions should also not be alarmed, for it seemed to him that, by focussing public interest and making a great success at one centre, they should only be recruiting interest and funds for the whole structure of technical education in the kingdom. It seemed to him that the new institution should draw its supply of students from both the struggling and the prosperous, and for this purpose scholarships and judicious aid of all kinds must be given to the struggling. The prosperous should be attracted to it, not as to a new playground, or a soft-hearted influence centre, but should be made to feel that it was a real training ground for battle, where their mental muscles could be made strong, quick, and flexible for the strenuous and exacting struggle that was before this nation in connection with industrial matters.

The Mosely Commission.

It is remarked by an influential American journal that the recent visit of the British Commission investigating American methods of technical education brings to the front a very serious question as to the value of that which they have found—"That technical instruction in England is in a highly unsatisfactory state admits of little doubt; it is quite certain also that the Commission discovered here some admirable institutions, but did they find a well-defined method of education which might fairly be said to be common to American technical schools? We think not, and on the contrary, if their investigations were at all as thorough as they were intended to be, they assuredly found that American institutions were on all sorts of planes of usefulness and representing all sorts of educational ideals. English technical instruction is essentially a development of the trade-school idea, very useful in itself, but far from being all-inclusive in its functions. Here the trade school as such is almost an unknown quantity, and so far as it here exists is of comparatively recent growth. That it may be useful when intelligently managed the correspondence schools which have assumed some of its functions bear witness; but they cannot be regarded as a sequent part of our general educational system, which is based as regards technical instruction, on the small university using that term in its American signification of an institution in which all sorts of things are taught. The main work of technical instruction in this country is done by the 'land-grant' colleges under State supervision and founded originally to provide instruction in 'agriculture and the mechanic arts.'

"In many instances the instruction in agriculture has been separated from that in the mechanic arts, and the latter has been merged in the general work of a State University; but it is an impressive fact that technical study has been in every State of the Union backed up by a strong local appreciation of its necessity. It is in response to this sentiment that courses in engineering have been developed, and because of its representation of local necessities that they have taken the various forms in which they now appear."

Mr. B. H. Thwaite in America.

Mr. B. H. Thwaite, during his stay in America, has been giving the readers of the *Iron Age* the benefit of some data relative to his latest type of Blast Furnace Gas Cleaning Plant.

The gas is led to a special form of washer of the simplest construction, this being equipped with a water seal, which not only enables the deposited dirt to be removed at any time, but also acts as a ready outlet of escape in the case of sudden rushes of gas. This apparatus reduces the temperature of the gases, and a considerable proportion of the water suspended in them is condensed. It is so arranged as to compel the gases to flow uniformly and repeatedly through the water, this being effected by the action of a centrifugal fan, which is sufficiently powerful to establish and maintain a 10-in. suction. From the washer the gas flows into an atmospheric tubular cooler, which may act as a recuperator of hot air if that should be required for any purpose. Usually, however, the tubes are exposed merely to the cooling influence of the atmosphere. They are open on the top and at the bottom, so that they can be readily cleaned by either mechanical means or, what is generally sufficient, by flushing them with water from an upper tank. This tank combines the two sets of tubes through which the gas flows first in an upward and then in a downward direction. From this apparatus the gas enters the centrifugal fan which is so arranged that any dirt which accumulates can be washed out readily. The fan not only draws the gas from the two elements of the plant already described, but it also forces the gas through two additional filtration elements for the sake of future purification. These act also as safety valves; that is to say, if, due to a fall of the burden or to explosions in the furnace—not uncommon occurrences—there is an abnormal quantity of dust in the gas. If it were not for the filtration elements this dust would to some extent gain access to the engine and create serious trouble. The filtration elements, which consist of a duplicate set of coke scrubbers and sawdust scrubbers, stop this dust, so that the gas when it enters the holder is pure and almost dry. The last element in the series is the governor holder, which establishes a constant pressure, regulating the supply of gas to the engine.

The Author of "De Magnete."

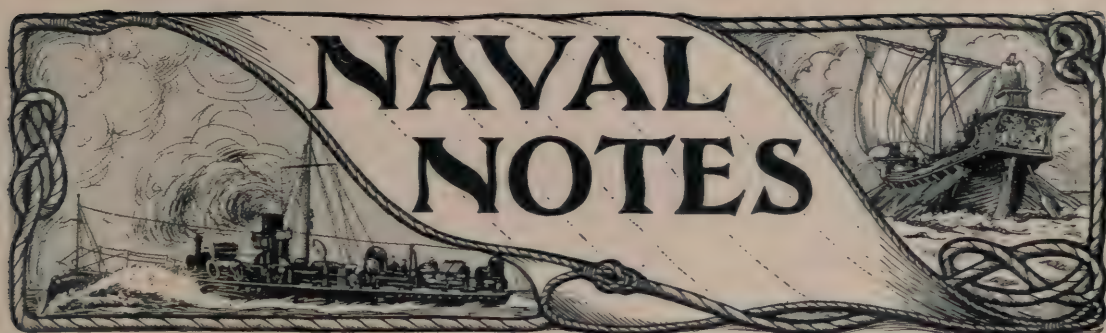
The tercentenary of the death of Dr. Gilbert, of Colchester, gave the Institute of Electrical Engineers an opportunity of doing honour to the memory of a man whose researches, forgotten by many, entitle him to be called the father of electrical science. On the 10th ult. a very interesting picture, by Mr. A. Ackland Hunt, showing Dr. Gilbert experimenting before Queen Elizabeth and her Court was formally presented by the Institution to the Borough of Colchester. Professor Silvanus Thompson so happily summed up the work of Dr. Gilbert that we cannot do better than quote his remarks direct. "Electricians," he said, "owed an enormous debt of gratitude to Gilbert, who for them was pre-eminent among all

the great men of Elizabeth's time. There had been Statesmen before Cecil, dramatists before Shakespeare, and philosophers before Bacon, but before Gilbert there was no electrician. He claimed admiration as the founder of electricity, and also of terrestrial magnetism; of the latter science, proceeding by the method of experiment, he laid the foundation in his book 'De Magnete,' and drew the inference that the earth itself was a magnet. In spite of the claims of a busy life as a physician, he devoted much time and money to scientific work. Astronomy owed three things to him—advocacy of the views of Copernicus in England, the conclusion that the fixed stars could not all be at the same distance from the earth, and the first known map of the moon. He also advanced the science of navigation. He was born at 2.30 p.m. on May 24th, 1544, at Colchester, in a house that was still standing, and for aught they knew to the contrary his death also took place in it on December 10th, 1603 (N.S.). Within a few yards of that house, which should be the Mecca of electricians, his bones were laid in the Church of Holy Trinity, where there was a monumental tablet to his memory."

The Mayor of Colchester assured the President and members of the Institute that the picture would be suitably hung upon the walls of the Town Hall of Gilbert's native town.

The Late Sir Frederick Bramwell.

It is not easy within the limits of a paragraph to pay a fitting tribute to the unique and striking personality of the late Sir Frederick Bramwell, whose active and useful career ended on November 30th. His sterling personal characteristics, genial temperament, and ready wit, may unhappily fade from the mind with the lapse of time, but he will long be remembered as the foremost arbitrator of the day in engineering matters—especially those affecting the mechanical engineer. The late baronet was born in 1818—the year which witnessed the founding of the Institution of Civil Engineers. His successful career extended over the best part of a century, distinguished above all others as the age of mechanical engineering. It is impossible to look back upon such a life without wonderment at the vitality of the man, the wide ramifications of his interests and the amount of work he was able to achieve in the half century which elapsed between 1853, when he commenced business on his own account, and the time of his demise. Few can claim the honour of having been president of three such institutions as the Institution of Civil Engineers, the Institution of Mechanical Engineers, and the British Association. His abilities were widely recognised both in the profession and out of it. He held the honorary degree of D.C.L. from the Universities of Oxford and Durham, and that of LL.D. from Cambridge and McGill. Other prominent features in the life of the late Baronet were, his election as Fellow of the Royal Society in 1873, his appointment on the Ordnance Committee in 1881, his appointment as Honorary Secretary of the Royal Institution in 1885, his Knighthood by Queen Victoria in 1881, and the baronetcy which was bestowed upon him in 1889.



MONTHLY NOTES ON NAVAL PROGRESS IN CONSTRUCTION AND ARMAMENT,

BY

N. I. D.

THE purchase by this country of the two battleships *Libertad* and *Constitution* building in this country for Chili, and the decision of the Admiralty to use the design of the *King Edward VII.* class for the three battleships to be built in the Government dockyards, has aroused a further discussion upon design and cognate matters. In this Magazine, about this time last year, I discussed the relative importance of the qualities and attributes required in design, whether for battleship, cruiser, or other purposes, and showed how they should be combined to make up what I called battleworthiness. It is well to remember, when discussing questions of design, that experts are not agreed altogether as to the exact relation that these qualities or attributes should bear to one another in the various classes of vessels. This is not to say that there is no general consensus of view as to the predominance of certain qualities for certain classes, but rather that the divergency of opinion is one of relative quantity. Everyone, it may be assumed, would place the quality of offence first in a battleship design, whereas in a cruiser speed would be the first quality looked for by many. It is true that a certain school have recently shown an inclination to place speed in a battleship more prominently forward than had previously been the case. But it seems fairly obvious that it is of no great account to be able to bring your ship speedily to the point of action if, when she arrives there, she is inferior in power of offence to the vessel by which she is to be opposed. Similarly seaworthiness, which I take to be a combination of elements including steadiness as a gun platform, and a reasonable amount of habitability for the crew as well as merely sea keeping ability, has of recent years taken a higher place than formerly. The contrast presented by the outward appearance of our modern battleships, and those for example of the "Admiral" class demonstrates clearly the movement in this direction. It has been said, and with some truth, that in endeavouring to obtain the greatest possible steadiness as a gun platform, and at the same time the greatest amount of seaworthiness, the naval constructor has to reconcile two fundamentally opposed qualities, since the more lively vessel is generally the more stable ship. In some tables, which I give below, I have endeavoured to show, by means of figures, the qualities of various classes of battleships. And although it would be a mistake, as Sir William White has so lucidly and conclusively demonstrated, to use these figures alone for the purpose of comparing one class of ship with another, they

should at least be valuable for the purpose of indicating the trend of opinion, in the various countries.

The method followed in the tables given below is to arrange the different types in order of age, the date given being that at which the vessels were presumably designed. It has seemed better to use this date than that of launch or completion, because it is obvious that unless modifications are made in the elements of the vessel during building, this is the right date to use for purposes of comparing design. Secondly, displacement is a measure of capacity; it is obvious that where there is large discrepancy in displacement there must have been sacrifices of some kind in the smaller vessel, and moreover, if in the smaller vessel there is also found to be a preponderance of any particular attribute over the corresponding quality in the larger vessel, so much greater must have been the sacrifice in other directions. Bearing on this question three important factors require consideration. These are coal capacity, coal consumption and speed. The coal capacity of a type is difficult to determine with precision. We are generally given two amounts: the bunker capacity at the normal displacement of the vessel and a larger amount, which is generally described as the maximum, and which, if the vessel carried it, would presumably increase her displacement and therefore affect both her consumption and speed. The coal consumption at various speeds would, if included, have considerably increased the space required for the tables. It has, therefore, been omitted, but it should certainly be taken into account in comparing design. The speed given in every case is that for which the ship and her machinery was designed, except where such speed was not attained on trial. Some vessels have, doubtless, exceeded their designed speed—the *Libertad*, for example, is reported to have attained over twenty knots—but to introduce these trial speeds would require also a description of the circumstances and conditions under which they were accomplished. In regard to armour, the maximum on barbets and secondary batteries has been placed in the tables, but here, again, merely an indication is given, for no real comparison of defensive power can be made, until the amount of area protected and the total weight assigned to protection are accurately known. Turning to gun power, instead of enumerating the guns, the weight of broadside has been substituted. This, however, should be supplemented, not only by the range and penetration of the guns, but by data very difficult to obtain respecting the supply of ammunition, and

the rate of aimed fire and the nature of the protection afforded to each character of ordnance.

The above remarks should indicate how difficult it is, merely by means of statistical tables, to arrive at any real comparison of design; the point aimed at has rather been to show the line of relative improvement and the tendency to advance in one or another quality among the many which are considered desirable and even essential.

GREAT BRITAIN.

BATTLESHIPS.

Name and Programme.	Displacement.	Coal Capacity	Speed.	Armour.	Weight of Broad-side.
	tons.	tons.	knots.	in.	lbs.
<i>London</i> .. (1898-1899)	15,000	900	18.0	12	4,112
<i>Duncan</i> .. (1899-1900)	14,000	900	19.0	11	4,075
<i>Libertad</i> .. (1899-1900)	11,800	800	19.0	10	3,487
<i>Queen</i> .. (1900-1901)	15,000	2,000	18.0	12	4,112
<i>King Edward VII.</i> (1901-1902)	16,350	950	18.5	12	4,747
		2,000		7	

From the above figures it is shown that the displacement of our battleships is gradually increasing, and with it an increase in all the other attributes of the ship. The contrast between the displacement of the *Libertad* and the other British ships is very striking, but it will be seen that it carries with it a great diminution in the weight of broadside and presumably in other matters not so apparent. Comparing the weight of metal thrown on one broadside by the *Libertad* and the *King Edward VII.*, it is noteworthy that if we subtract from both ships the heaviest guns, we find that the broadside of the secondary battery of the *King Edward*, consisting of two 9.2-in., five 6-in., and seven 3-in. guns, gives us a total of 1,347 lb., whereas in the *Libertad* the secondary battery of seven 7.5-in. and seven 14-pounders, gives 1,487 lb., a difference of 140 lb. against the *King Edward*, and this difference is still more marked if the lighter guns on both sides are subtracted; then the *King Edward* can only throw 760 lb. of metal to 1,400 from the *Libertad*.

There are many other matters in connection with a comparison between the *Libertad* and the Admiralty designs which require elucidation. For example, an important point concerns the height at which the 7.5-in. guns of the *Libertad* are carried above water, and the possibility of their use in a heavy seaway, the length of these guns, and particularly of that portion of the chase which is outside the vessel, is considerably more than is the case with the 6-in. guns carried in English ships. Until, therefore, this ship and her sister have been tried at sea under varying conditions some uncertainty will exist about their powers of offence in certain circumstances. Doubtless, now that the Admiralty have acquired these vessels they will seize the opportunity to test them in company with vessels of Government design. In this way many important questions which have,

at times, been mooted in comparisons made between British ships and ships built in this country for foreign Powers may be settled.

ARMOURED CRUISERS.

Name and Programme.	Displacement.	Coal Capacity	Speed.	Armour	Weight of Broad-side.
	tons.	tons.	knots.	in.	lbs.
<i>Cressy</i> .. (1898-1899)	12,000	800	21.0	6	1,448
<i>Kent</i> .. (1899-1900)	9,800	1,600	23.0	5	962
<i>Drake</i> .. (1900-1901)	14,100	1,250	23.0	6	1,647
<i>Devonshire</i> .. (1901-1902)	10,700	2,500	22.25	6	975
<i>Duke of Edinburgh</i> (1902-1903)	13,550	800	22.0	6	2,020
		1,000		6	
		2,500		6	

As between the *Kent* and the *Devonshire* the additional displacement is principally devoted to increased protection, the difference in weight of broadside being small. On the other hand the *Duke of Edinburgh*, with a slightly less displacement than the *Drake*, has increased protection given to the ship and an increase in gun power, with a possible loss in speed, although it is hoped that the result on trial will be better than that estimated.

As a result of the recent manoeuvres we have been told that the Admiralty incline to a policy of eliminating all the smaller classes of cruisers, retaining the heavy armoured ships of which the *Duke of Edinburgh* is the latest expression, and then descending to the class of scouts which are yet under construction. It is evident, looking at the above tables, that greater gun power is now considered a desideratum.

FRANCE.

BATTLESHIPS.

Name.	Displacement.	Coal Capacity	Sp.-ed.	Armour.	Weight of Broad-side.
	tons.	tons.	knots.	in.	lbs.
<i>Jéna</i> .. (1897-1898)	12,052	820	18.0	12	3,429
<i>Suffren</i> .. (1898-1899)	12,728	1,100	18.0	4	3,528
<i>Republique</i> .. (1901-1902)	14,865	820	18.0	12	3,802
<i>Liberté</i> .. (1902-1903)	14,927	1,150	18.0	6	4,032
		900		12	
		1,850		6	

In France the displacement of the battleships is on an increase, and without any corresponding advance in the other elements, with the exception of gun power. The *Liberté* class are to be armed with ten 7.6-in. guns, in place of the eighteen 6.4-in. which the *Republique*

will carry, and an addition will be made of eight 3·9-in. The disposition of the guns is slightly different, because, instead of a couple of 6·4-in. guns in each of the six turrets, one 7·6-in. will be mounted, in each, while four others of the same calibre will be in casemates. Thus another instance is given of the little regard which is paid to homogeneity in the French fleet.

ARMoured CRUISERS.

Name.	Displacement.	Coal Capacity	Speed.	Armour.	Weight of Broad-side.
	tons.	tons.	knots.	in.	lbs.
<i>Jeanne d'Arc</i> .. 1896	11,329	1,400 2,100 1,020	23.0	— 5 6	843
<i>Montcalm</i> .. (1897-1898)	9,517	1,600 880	21.0	— 4	838
<i>Kleber</i> .. (1898-1899)	7,700	1,200 970	21.0	3½ 7½	657
<i>Marseillaise</i> .. (1899-1900)	10,014	1,590 1,320	21.0	— 5	869
<i>Victor Hugo</i> .. (1901-1902)	12,550	2,100	22.0	— 5 6	1,554
<i>Ernest Renan</i> .. (1902-1903)	13,562	2,300	23.0	— 6	1,345

As compared with the British cruisers the French armoured ships show an approximation in point of displacement and in speed, but the weight of broadside fire of the latest type is considerably less than that of the *Duke of Edinburgh* of about the same tonnage. This is owing to the fact that the British vessels carry six 9·2-in. guns, whereas the *Ernest Renan* is only provided with two guns of similar calibre. Nor is the balance redressed by any corresponding increase in the number of guns of smaller calibre.

GERMANY.

BATTLESHIPS.

Name.	Displacement.	Coal Capacity	Speed.	Armour.	Weight of Broad-side.
	tons.	tons.	knots.	in.	lbs.
<i>Wittelsbach</i> .. (1898-1899)	11,800	700 1,450 700	18.0	— 6 10	2,777
<i>Braunschweig</i> .. (1900-1901)	13,200	1,600	18.0	— 5½	3,028

In point of age and displacement, the *Wittelsbach* class may be compared with the *Libertad*, but the latter ship throws a heavier weight of metal owing to her being provided with 7·5-in. guns in place of 5·9-in. as in the German ship. The latter also will hardly compare in point of speed with the Chilean

design. In Germany, however, the same tendency occurs to increase displacement and armament, even at the sacrifice of speed and protection.

ARMoured CRUISERS.

Name.	Displacement.	Coal Capacity	Speed.	Armour.	Weight of Broad-side.
	tons.	tons.	knots.	in.	lbs.
<i>Prinz Heinrich</i> .. (1897-1898)	8,930	950 1,500 950	20.0	6 4 6	1,513
<i>Prinz Adalbert</i> .. (1900-1901)	9,050	1,500	21.0	— 4	1,816

Germany has not yet essayed the construction of many armoured cruisers, nor have those in hand shown that increase in displacement which is to be found elsewhere. But, although the tonnage of the three ships of the *Prinz Adalbert* class is about the same as that of the British *Kent*, the German armament works out to nearly twice the weight of that of the English vessel, her heaviest guns being of 8·2-in. calibre, and those of the second size, 5·9-in. instead of 3-in., as in the English ship. This increase in weight of broadside has been obtained without apparently a diminution of protection, but probably with a loss in speed.

RUSSIA.

BATTLESHIPS.

Name.	Displacement.	Coal Capacity	Speed.	Armour.	Weight of Broad-side.
	tons.	tons.	knots.	in.	lbs.
<i>Retvisan</i> .. (1897-1898)	12,700	1,000 2,000	18	— 5 12	3,434
<i>Tavrichesky</i> .. (1897-1898)	12,500	670 900	18	— 5 11	3,676
<i>Tsarevitch</i> .. (1898-1899)	13,100	1,350 1,250	18	— 6½ 10	3,516
<i>Borodino</i> .. (1898-1899)	13,600	2,000	18	— 6	3,516
<i>Joann Zlatoust</i> .. <i>Pavel I.</i> .. (1902-1903)	12,500 16,350	— —	18 18	11 —	4,128 —

According to the most recent reports about the new Russian battleships, those which are to be built in the Baltic will be very similar in design to that of the *Edward VII.* class. In tonnage and in speed they are apparently to be alike, but no trustworthy particulars in regard to armament have yet come to hand. Of the vessels to be built in the Black Sea, they are apparently with some modifications, similar in design to the *Tavrichesky*. The condition of service of the vessels built in the Black Sea doubtless finds expression in the design chosen for those ships. If, as is likely, the British Government is in possession of the design chosen for the *Imperator Pavel I.*, it may be that this knowledge had its effect upon the decision recently arrived at to build three more ships of the *King Edward VII.* class.

ARMoured CRUISERS.

Name.	Displacement.	Coal Capacity	Speed.	Armour.	Weight of Broad-side.
	tons.	tons.	knots.	in.	lbs.
<i>Gromoboi</i> .. (1897-1898)	12,336	800 2,500 750	20	6 4½ 7	1,197*
<i>Bayan</i> .. (1898-1899)	7,800	1,100	22	3	952
<i>New Design</i> .. (1903-1904)	—	—	—	—	—

* Does not include six 4.7-in. guns which one authority says are carried but which others omit.

Particulars of the design of the new armoured cruiser which Russia is reported to be about to build in the Baltic are yet wanting. It is noteworthy, however, of the *Bayan*, that on a displacement somewhat less than that of the *Kent*, an armament is carried of two 8-in. guns and eight 6-in. as against the fourteen 6-in. in the English ship. The *Devonshire*, a modified *Kent*, carries a very similar armament to the Russian cruiser.

UNITED STATES.

BATTLESHIPS.

Name.	Displacement.	Coal Capacity	Speed.	Armour.	Weight of Broad-side.
	tons.	tons.	knots.	in.	lbs.
<i>Maine</i> .. (1898)	12,300	1,000 2,000 900	18.6	12 6 11	4,242
<i>New Jersey</i> .. (1899)	14,948	1,900 2,000	19.0	6 10	5,584
<i>Connecticut</i> .. (1902)	16,000	2,200 1,750	18.0	7 12	5,530
<i>Idaho</i> .. (1903)	13,000	2,000 900	16.0	10 12	5,309
<i>Kansas</i> .. (1903)	16,000	2,200	18.0	10	5,530

The discussion upon design which has for some time been carried on in the United States resulted, as is well known, in two types being chosen, the smaller of which may be said to take the place of the larger armoured cruisers now building elsewhere. Another subject of controversy was the system of superposed turrets, originally tried in the *Kearsarge* class, and reappearing in the *New Jersey* ships. Recently it is said to have been shown that the turret structures of the *Kearsarge* and *Kentucky* are weaker than is thought to be entirely satisfactory, and, as a result, the similar structures of the *New Jersey* class will be strengthened. But it is in point of weight of broadside that the American ships are most conspicuous. How this is obtained on the displacement and without loss of speed or neglect of protection, has not been explained. Possibly, an investigation and comparison with our standards of the elements brought together in the *Libertad* may throw light on this matter.

ARMoured CRUISERS.

Name.	Displacement.	Coal Capacity	Speed.	Armour.	Weight of Broad-side.
	tons.	tons.	knots.	in.	lbs.
<i>Milwaukee</i> .. (1900)	9,700	650 1,500 900	22.0	4 4 6	926
<i>California</i> .. (1900)	13,680	2,000 900	22.0	5 9	1,826
<i>Tennessee</i> .. (1902)	14,500	2,000	22.0	5	2,954

In point of age, the *Tennessee* class compares with the British *Du'le of Edinburgh*. With a displacement one thousand tons heavier and considerably stronger protection for the heavy guns, the weight of broadside is more than 900 lb. in excess of that thrown by the English ship. The *Tennessee* carries four 10-in. guns to the *Du'le of Edinburgh's* six 9.2-in., but the disparity in this respect is made up by an additional six 6-in. guns in the United States cruiser as well as twenty-two 3-in. I have indicated above other points for comparison with foreign vessels, but the gradual progress in the American designs is clearly indicated by the figures in this table.

JAPAN.

BATTLESHIPS.

Name.	Displacement.	Coal Capacity	Speed.	Armour.	Weight of Broad-side.
	tons.	tons.	knots.	in.	lbs.
<i>Hatsuse</i> .. (1896)	15,000	1,100 1,400 1,000	18.0	14 6 14	4,240
<i>Asahi</i> .. (1896)	15,200	1,400 700	18.0	6 14	4,240
<i>Mikasa</i> .. (1897)	15,200	1,500	18.0	6	4,225

It is unnecessary to add to the information afforded above. We are told that a new programme is in course of consideration, if, indeed, it is not already settled, and we may be sure that the Japanese will not fail to take advantage of all that has been learnt by other countries.

ARMoured CRUISERS.

Name.	Displacement.	Coal Capacity	Speed.	Armour.	Weight of Broad-side.
	tons.	tons.	tons.	in.	lbs.
<i>Asama</i> .. (1897)	9,750	600 1,200 600	22.0	6 6 6	3,568
<i>Yakumo</i> .. (1897)	9,850	1,100	20.0	6 6	3,368
<i>Azuma</i> .. (1898)	9,436	700	21.0	6 6	3,368
<i>Idzumo</i> .. (1898)	9,800	1,600	20.75	6	3,568



SHIPBUILDING NEWS.

The Outlook.

By the time these lines are in print the shipbuilding returns of the year will have been completed. But while we write the figures are not available, so comment on the business of the past year must be deferred until next month. From the returns we have received up to the end of November it seems evident that the output of the shipyards in 1903 will prove to have been considerably short of that of 1902, by, we should say, not less than 100,000 tons. Perhaps even as much as 200,000 tons, inasmuch as the Scotch record, up to the end of November, was 88,500 tons short of the corresponding eleven months. And Scotland all last year was much busier than the other shipbuilding centres. Latterly, however, it did seem as if more new contracts (and they are not very numerous, after all) have been booked on the North-East of England than by the Scotch shipbuilders. But it is noteworthy that many of the Scotch shipbuilders do not report the contracts they receive for small craft, which go to swell the year's tonnage without appearing in the monthly reports of orders booked. Thus it is that the year's total usually comes out above the estimates. Again, Lloyds' official returns of the vessels "under construction" may include a lot of the same tonnage in the reports of two years. There are, for instance, cases of vessels launched in 1902 which might have been completed and sent to sea in that year, but which have been laid up, unfinished, in builders' hands. Such vessels will appear in the tonnage "under construction" in both years, though not in the builders' returns of launches.

Expected Orders Diverted.

The year 1904, then, opens with no great promise in the shipbuilding world. Some of the large yards specially equipped for the building of large liners and warships will be tolerably well off for work for some months to come, even if they book no new contracts, but even with them there is the disappointment caused by the decision of the Admiralty to build the three battleships of the 1903 Naval Programme in the Dockyards, instead of by contract as originally intended. Thus, three yards are deprived of expected orders. However, three other ships which were to have been laid down in the dockyards in 1904 will, in place of them, be given out to contract, the present change having been made to keep the staff of the Dockyards together and well engaged. The ordinary yards given up to the production of cargo boats and smaller craft will be poorly employed, and it is to be feared that some of them will have to be closed altogether if there is not an access of new orders soon. And of that there is not much probability in the state of the freight market and the growing

depression in general trade. But one can never tell. A political turn-up in the Far East or in South America may cause a sudden demand for shipping. There are, happily, no symptoms of labour disturbances at the opening of the year. The men in the East Coast shipyards seem to have made a virtue of necessity and accepted the reductions of five per cent. asked by the employers last month, and the men in the marine engine shops now forbear to press for an advance in view of the slackness in other branches of engineering in which, a while ago, they had opportunity of alternative employment.

Shipbuilding Costs.

Shipbuilding costs are, of course, down a good deal as compared with the beginning of last year. Steel ship plates have been reduced to £5 10s. in the North of England and in Scotland, and angles are down to £5 to £5 7s. 6d. With cheap pig iron (and hematite is lower proportionally than ordinary iron), and with the probability of American and German plates being soon on offer, the prospect is rather of cheaper shipbuilding, yet somehow shipowners do not look so much for lower costs, which they admit to be low already, as to better prospective employment for their vessels. Steamers of large size have recently been contracted for at as low as £5 12s. 6d. per ton dead-weight, a price on which the builders can have no margin. It is probable, however, that there will be some run on turbine steamers this year. The example set by the Allan line (whose second turbine boat is to be built by Messrs. Alexander Stephen and Sons, Ltd., Linthouse, Glasgow, as a sister ship to the one being built by Messrs. Workman, Clark and Co., Belfast), will doubtless be followed. Indeed, during the last month of 1903 Messrs. Wm. Denny and Bros., of Dumbarton, had on hand contracts for five large turbine steamers for the Colonies.

Increase of Maritime Disasters.

The past year has been a pretty severe one upon underwriters, not only in this country but also in France and Germany. Indeed, so much insurance has been transferred to this country of late that it almost looks as if French and German underwriters were scared. The Bureau Veritas have published a list of maritime disasters reported during the month of October concerning all flags. Of sailing vessels reported lost, there were 11 American, 1 Argentine, 2 Brazilian, 33 British, 5 Danish, 2 Dutch, 5 French, 3 German, 3 Italian, 19 Norwegian, 1 Portuguese, 4 Russian, 1 Spanish, 12 Swedish, 3 Turkish—total 105. Of steamers reported lost there were 2 American, 2 Austrian, 17 British, 1 Chilean, 1 German, 5 Italian, 1 Japanese, 3 Norwegian, 1 Swedish—total 33. The St. Lawrence season, which closed at end of November

ast, was open in 1902 to December 8th. In 1903 the casualties were numerous in spite of the improvements in the channel which the Canadian Government have effected. There were fifteen accidents there altogether, and two of the vessels—the *Monterou* and the *Topaz*—became total wrecks. In 1902 there were eleven casualties, with no total losses, and in 1901 there were five strandings, also without total losses. In 1900 the casualties numbered five, and only four of the boats were saved. Thus, 1903 was a good deal worse than its two immediate predecessors, while it must also have been worse, from a monetary point of view, than the three years preceding 1901.

The *Baltic*.

The launch of the largest ship in the world by Messrs. Harland and Wolff, Ltd., Belfast, for the White Star Line of the Morgan Combine, was briefly alluded to in the December number of PAGE'S MAGAZINE. The *Baltic*, as she is named, is not only the largest, but is also, in many respects, the finest vessel afloat. The new vessel will have accommodation on the same lines as the *Celtic* and the *Cedric*, but more commodious. The general arrangement is similar to these vessels, a continuous shade-deck running fore and aft, with three tiers of deck houses and two promenade decks above. On the upper promenade deck is the first-class smoking-room and library, and the two houses below contain the deck state-rooms. The first-class dining saloon is on the upper deck, and all the first-class accommodation is amidships. Immediately abaft the first-class is the second-class accommodation, and also a comfortable smoking-room and library for this class. The third-class passengers are provided for abaft the second-class, and to a limited extent at the fore end of the vessel. A great feature in this accommodation is the large number of state-rooms of two, three and four berths, and the commodious and comfortable dining-rooms. There is accommodation for nearly three thousand passengers, besides quarters for a crew of about three hundred and fifty. The decorations are artistic and the appointments handsome and luxurious. In addition to the ordinary state-rooms, there are suits of bed, sitting and bath-rooms, also single-berth state-rooms. As in the other large steamers of this type, one of the most notable features in the *Baltic* is the grand dining saloon, situated on the upper deck, and extending the full width of the ship, 75 ft. It contains seating accommodation for three hundred and seventy people. The first-class smoking-room and library are also fine apartments, and the second-class public rooms are elegant and comfortable. The heating and ventilating arrangements of the ship are most complete, and the *Baltic* will be fitted with winches and other loading and discharging arrangements of the latest and most efficient type. There will be large refrigerating chambers for the carriage of chilled beef, the machines for working these being on the CO₂ method. The engines are arranged on the "balanced" principle, which practically does away with vibration. The twin engines and twin screws afford another element of safety to the ship and passengers, and the possibility of danger is reduced to a minimum. The *Baltic* is to be ready for the summer service of the White Star Line.

Shipbuilding Ancient and Modern.

Mr. John Ward, F.S.A., in his remarkably complete book, "Greek Coins and Their Parent Cities,"* has an

interesting reference to the shipbuilding of the Ancients, as contrasted with the products of our modern yards. "There is," he says, "a description of the wonderful ship built by Archimedes in the pages of Athenæus, an historian or anecdote-monger of Naucratis. This ship was so large that, like the *Great Eastern* of modern times, she 'stuck' when they tried to launch her. Whereupon Archimedes devised his screw, used it as a means of propulsion, and launched the huge vessel easily. But the strain had made the big ship leak, and she became water-logged. Another development of his wondrous screw, and she was quickly pumped dry, and the leaks, no doubt, were caulked securely. This ship had real gardens of great extent, a wrestling ground, rooms full of pictures and statuary, floors of tessellated marble decorated with subjects from Homer. It possessed barracks for soldiers and stabling for cavalry, and carried, besides an enormous cargo of grain, eight fortified towers. When it was completed there was no harbour in Sicily fit to hold it, and so Hieron made a present of the costly toy to Ptolemy Philadelphus of Egypt. We, unfortunately, do not know its measurements, but it must have been a monster, and was the greatest ship the world had ever seen. Ptolemy had also built a great vessel, of which we have measurements, but the Syracusan ship eclipsed it. Ptolemy's ship was 425 feet long and 60 feet beam, 72 feet deep, and seems to have been a vessel of war; while Hieron's was intended to carry grain—there was a famine in Egypt, and he sent the ship, full of grain, to Alexandria.

It is worth noting the size of the *Celtic*, the greatest ship of our time, built in Belfast in 1901.* Its designer, the Right Hon. W. J. Pirrie, L.L.D., has given me the following particulars: Length, 700 feet; breadth, 75 feet; depth, 49 feet. The 'displacement,' when at full load draught, is 37,700 tons. Messrs. Harland and Wolff have not as yet introduced gardens, statuary, or wrestling grounds, into their vessels, but, no doubt, those may come in time."

Palmer Shipbuilding Yard.

The ever-increasing dimensions of modern vessels have necessitated corresponding changes in the ship yards.

The Palmer Shipbuilding and Iron Company have lately completed the work of lengthening their berths. They have rearranged their engine-shops, thus enabling them to add the space hitherto occupied by the machine-shop to the shipyard, while new shops for joiners and cabinet makers have replaced the buildings destroyed by fire. These will rank among the finest in the world.

The building, which is in three storeys, has a length of 196 ft., the sawpit underneath being 70 ft. long, 68 ft. wide, and 10 ft. deep. A new and spacious erecting shop has been constructed, with every facility for dealing with an increased volume of work.

The *Armada* Castle.

The Union Castle Liner *Armada* Castle, one of the largest mail steamers built on the Clyde, recently sailed on her first voyage to South Africa, having completed a series of satisfactory speed trials. The new vessel possesses a gross tonnage of 12,973; her horse-power is 12,500; and her speed will be some 17 knots, although she is capable of doing more; while the vessel has been very luxuriously fitted, so that first-class passengers en route for South Africa may lack no material comfort. Thorough provision has also been made for the needs of second and third-class passengers.

The *Kenilworth* Castle, a sister ship to the *Armada*, is being built by Messrs. Harland and Wolff.

* This designation was correct when the volume first appeared. The *s.s. Baltic* now holds the record.—Ed.

* Published by John Murray. 25s. net.

ELECTRICAL AFFAIRS.

BY

E. KILBURN SCOTT, M.I.E.E., A.M.Inst.C.E.

An Electrical Method of Straightening Wire.

Amongst the various ingenious temporary expedients which the writer has seen employed in electrical works he calls to mind a method of straightening badly kinked wire which is probably unique. Some old armature wire had been thrown on one side as only fit for the scrap-bin, but it happened to be just the gauge required for a particular purpose in the test-room. The following method was therefore adopted to straighten it: One end was attached to a wooden bench and the other fastened to a stout piece of wood which was held by an assistant. A large current was then sent momentarily through the wire from a set of accumulators and at the same moment the assistant gave it a good sharp pull, the result being a beautifully straight piece of wire. It was no doubt reduced in diameter, but so slightly as to be practically immeasurable.

Reducing Size of Copper Wire.

There is just a possibility that the above method could be employed for reducing the gauge of copper wire, because whatever change takes place in the diameter will be equal right through the full length of wire. In case anyone thinks of patenting the idea, the writer may say it was employed at the Electric Construction Company quite six years ago.

It may be mentioned that it is a very real convenience to be able to reduce the gauge of wire occasionally. In large dynamo manufacture, for example, it often happens that in the larger gauges of shunt wire the proper diameter to give the requisite number of ampere turns comes between two standard gauges. The usual course under these circumstances is to wind the coil with two sizes, that is the next sizes larger and smaller, proportioning the turns of each for the required resistance. There is an obvious objection to this in that the joint in the interior of the coil is a possible source of trouble, and it is also so easy for the winder to put on an incorrect number of turns.

Waste of Copper Wire in Electrical Factories.

Amongst the other economies which might be effected in a dynamo manufacturing works is the using up of old material, such as armature and transformer iron, and particularly copper wire, etc. The latter is always a source of great loss; for example a field coil will be wound, and after being varnished and dried, the cotton covering breaks down under test. I have actually seen such wire carelessly unwound, quite spoiling it for use again and put in the copper scrap-bin. As it cost probably over 1s. a pound, and as scrap only fetched 3d. a pound there was naturally an enormous loss at the end of the year. Nowadays, of course, such wire will, in many cases, be carefully unwound, stripped of its insulation, and then re-covered. Every dynamo works worth the name should have a stripping and cotton covering machine.

Magnetic Steel Stampings.

The using over again of mild steel stampings for armatures, transformers, etc., is not easily dealt with, because the design of dynamo machines changes so rapidly. Now that sizes are becoming more standardised, however, it may be possible to arrange to use such stampings over again, after they have been well annealed.

In the case of static transformers, it is recognised that after a few years it pays to dismantle the transformer core, and carefully anneal the stampings so as to bring them back to their original hysteretic state. For, whatever statements transformer manufacturers and other

may put forward as to iron being obtainable which will not show ageing loss, it is a moral certainty that every transformer must deteriorate in time. Of course, some iron goes off more rapidly than others; in fact, there seems to be much uncertainty about the whole question of magnetic steel or iron.

It seems to the writer that this and other similar investigations should be undertaken by the Institution of Electrical Engineers. Such activity would be more in keeping with the Institution than aping at Trades Unionism by circularising Town Clerks on questions of what is and is not etiquette.

Wanted a New Steel.

It is a well-known fact in the building trades that certain kinds of stone have the valuable property of being easily worked when freshly quarried, and which become quite hard after they have weathered some time. Other natural materials, such as slate for example, appear to possess something of this property, and the writer is not sure that it cannot be traced to the metals present in the material. Now why should not steel or metals of similar nature be invented which would be capable of being easily worked, but which would improve in strength and rigidity after having been exposed to air or water, or say by being temporarily enclosed in the fumes of certain gases?

The "Electrically Driven" Centrifugal Pump.

The development of the design and rise of the centrifugal pump to its present position of importance has synchronised almost exactly with the rise of the electric motor, and it is interesting to note that they are both simple *rotative* pieces of mechanism, and essentially built for operation at high speed.

When coupled together the two make an exceedingly neat unit taking up little space for the power developed and requiring practically no attention. At the same time the possibilities of the electrically driven centrifugal pump do not seem to be fully appreciated, as is shown, for example, by the employment of ram pumps where centrifugals, working in series, would do quite as well and be much cheaper.

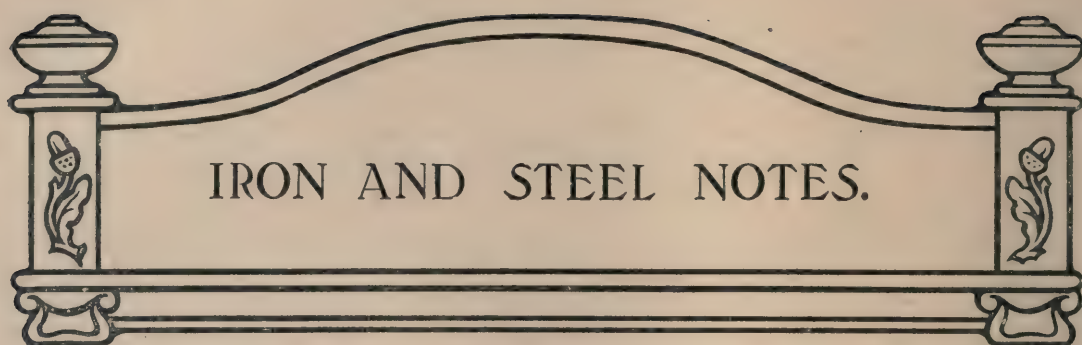
Without encroaching on high lift work, there is a wide field for the centrifugal pump in low lifts, such as emptying snags, filling reservoirs, moving circulating water, sewage pumping, unwatering docks, etc.

Lowering Loans on an Electric Crane.

In the three-motor electric crane, where the load is lowered on the mechanical brake, a somewhat complicated piece of mechanism is required to connect between the moving crab and the handle in the attendant's cage.

This can be avoided if the regenerative idea is applied and the connections so arranged that the motor can run temporarily as a dynamo, the current generated when lowering being dissipated by means of resistances. With a three-phase motor the idea is similar to that on three-phase mountain railways in Switzerland. In applying the idea to a continuous current series motor, the connections are rather more complicated, but judging by the results obtained by the Schnckert Company the system works perfectly.

One advantage of this electrical method of lowering is that the movement of the load can be adjusted with very great nicety, whereas when lowering is effected on the mechanical brake there is great danger of the load being lowered jerkily, and it is not nearly so safe.



IRON AND STEEL NOTES.

American Methods in the Steel Trade.

In the course of an excellent paper contributed to the West of Scotland Iron and Steel Institute, Mr. H. G. Waddie pointed out what he considered to be the real difference between the management of American Steel Mills and the British method.

The central idea of American mill practice was to get the largest possible output with the smallest pay-roll; and to attain this object all available labour-saving appliances were introduced, and continuous working, with the aid, where possible, of continuous furnaces, had brought this system of working to a stage of comparative perfection. Wherever the movement of the material through the mill was independent of physical effort, it was obvious that more work would be accomplished, as the continuous flow of material from one department to the other was only dependent on the furnace capacity. The successful introduction of labour-saving methods was dependent as much on the quality of labour employed as it was on the capital invested.

The prominence given to young men in the States was a matter of surprise to many, but he saw no reason for preference being shown to the older men irrespective of ability, and he feared this was found the case in British practice. Why, he asked, should they stick to the apprenticeship system at home?

Of what use was it to talk about bursaries and aids to pushing boys if they were to be forced to work for next to nothing during the period when they ought to be gaining a knowledge of their own value and acquiring that spirit of independence which is the feature of the American boy?

The subject of cheap production of iron and steel in the United States was not entirely due, in his opinion, to any great advance in plant or machinery, but rather to exceptionally cheap raw material, transportation, and the extensive scale on which operations were conducted.

Among other points mentioned by Mr. Waddie were, the greater remuneration offered in the States for good executive ability. Longer hours were worked, and the number of ordinary or unskilled labourers was not worth mentioning. Another feature of the American method was the distribution of the mills over a wider area of ground, while at home they were usually handicapped

by the dimensions of the land at their disposal. The American mill was put down to make certain sections, and there was no endeavour to tackle every kind of steel order that might be offered. Again, wherever one went, most noticeable to the unaccustomed British ear in the mills, was the hum of the various motors at work all over the place, and why this power had taken so long to obtain a hold in the home works was a mystery.

Some Criticisms.

Mr. Waddie's paper gave rise to such an interesting discussion that we think no apology will be necessary if we devote some further space to the subject.

Mr. James Crawford remarked that with regard to machinery, and the American methods of working the same, described by Mr. Waddie, these were the elaborate appliances for carrying the material direct from the iron beds to the steel works, and turning out the finished article in the way of rails, plates, etc., all of which, they were led to believe, was done by the magic wand of the switch. He thought that when put in a technical way this read very nicely, but in actual practice it did not work out to give the best results. Anyone knew perfectly well that in taking iron direct from the blast furnace there was not only the saving of labour to be considered, but they had to know if the iron was of the right quality as regards alloys before they could get the best results. For instance, they might be saving 6d. on one hand and losing 1s. 6d. on the other; the latter due to waste and defective material.

By the American methods of working great economies were claimed. Say, in producing 500 tons per day, a saving of 4s. to 5s. per ton would be effected. But if they took into account this supposed saving, and saw what it came to per annum, they would find that the American works should be able to pay 30 or 40 per cent., even if they only saved the money which they saved by labour; this without considering other conditions, such as tariffs, etc. He had worked both practices, and, to his mind, the American figures given for saving would not bear investigation.

He did not wish them to imagine that he was not in favour of economies, because improvements would

undoubtedly go on, but it was quite a different thing to adopt seeming improvements which were injurious to themselves. Besides they had to remember that a great number of the American methods adopted in this country had not proved successful.

Mr. J. Hamilton opined that there was a good deal of work done in this country by hand labour that ought to be done by machinery, and by the employment of the latter, he thought they would have very much better outputs. Everything that was reasonable in the way of improved machinery he thought they ought to adopt.

Talkers and Workers.

Mr. H. Bumby, in the course of his contribution to the discussion, said that according to American talkers—the workers know better—blast-furnace working was simply a question of putting in so many tons of air at the bottom of the furnace and so many tons of ore and fuel at the top and nothing more was required. That was the style of the American articles that came to them from the other side; and unfortunately they sometimes believed them. The fact was that in America, or rather, at Pittsburg and its neighbourhood, with the magnificent Connellsville coke and Lake Superior ore, conditions were favourable for getting enormous outputs; and the stipulations as to quality were not so stringent as with us. When these furnaces were copied here and they tried to make a very good pig iron out of very indifferent materials, the result was not altogether satisfactory to those who provided capital for the experiment.

Mr. P. N. Cunningham said that the Americans were undoubtedly able by electrical appliances and devices to handle large quantities of materials quickly. The application of electricity was being looked into in this country very strongly; and he thought that this went to show that we were not altogether standing still, but that radical improvements would be made very shortly in the iron and steel business in this country.

In regard to the operation of mills in America, he thought that they had greater waste in working material from the mills than we have here. Some years ago a large amount of scrap was sent here from the United States, a large proportion of which, he considered, was quite capable of being rolled into good material.

Mr. W. G. Turnbull thought that there was not much future for water power in Scotland, especially for iron and steel works. He was of opinion that the best future for the manufacture of steel was in blast furnace and steel works in combination, running the molten metal direct from the blast furnace to the steel-melting furnaces, and utilising the waste gases from the blast furnaces in gas engines for not only blowing purposes, but for the distribution of electrical power. With regard to Mr. Waddie's remarks about the apprentice system, he thought that there was now a feeling amongst many of the leading engineers that an apprenticeship of five years was unnecessarily long, and many of the best employers were now making arrangements that their apprentices should have six months' practical training in the workshop and six months' technical training at college during the year; in other words, 2½ years' practical and 2½ years' technical training during the apprenticeship, which he

thought would be an improvement on the present systems and produce a much better class of managers.

Open-Hearth Basic Steel.

Before the same Society Mr. G. A. Wilson read an interesting paper entitled "Some Practical Hints on the Manufacture of Open-Hearth Basic Steel."

Discussing the direct or hot-metal processes, he remarked that there were three different systems at present in practice—namely, the Talbot continuous process, which was at work at the Frodingham Iron and Steel Co.'s works (and here he might say that he expected to start a 200-ton furnace at their place in the first week in the new year); the Bertrand-Thiel process, at the Earl of Dudley's Round Oak works; and the direct process, in operation at their Clarence and Britannia works.

It was possible that each of these systems might have advocates present, who would advance the claims of the process which he individually favoured.

In his opinion the direct process was the correct one; and he thought he was not going beyond the mark in saying that steel makers who wished to "line up," as the Yankees say, would have to adopt it, if they wanted to keep abreast of the times. It was claimed for the Talbot process that it worked very well at Frodingham. His own opinion was that if there was one place in the country where there was a chance to work it successfully it was at Frodingham, because undoubtedly they had the best and most suitable iron to deal with.

Taking into consideration the class of iron they had in the Cleveland district, and from the information he had from Round Oak, he thought the Bertrand-Thiel process was a very good one, and well worth the consideration of anyone who might be seriously thinking of adopting any of the direct processes. Personally, he had had no practical experience of the Talbot, and very little of the Bertrand-Thiel process.

As regards their own direct process at Middlesbrough, he was pleased to say that they were doing very well. At the Britannia works, they had a mixer with a capacity of 350 tons, and at the Clarence works one capable of holding about 250 tons. Both worked by producer gas.

The question might be asked, "Why a mixer?" Well, in his mind, it was everything; because they could then guarantee an almost uniform class of metal to the melting furnaces, and they were also in a position to "doctor" it in the mixer if they happened to be getting a "run" of inferior metal from the blast furnaces.

The metal came from the blast furnace in 15-ton ladles, and was poured into the mixer. Oxide of iron and limestone were charged into the mixer to reduce the silicon in the metal to about .8 per cent., and they could also deal partly with the sulphur.

At the Clarence works the metal from the mixer was then poured into 25-ton ladles and taken to the steel furnaces, where the ladle was lifted on a hydraulic lift and the metal poured down the spout into the furnace, which had been previously charged with ore and limestone sufficient to remove most of the silicon, carbon and phosphorus. At the Britannia works the only difference was that they brought the metal from the mixer with the

75-ton overhead electric crane, which they also used in the casting pit.

The metal as it came from the mixer contained about .8 per cent. of silicon, and on an average about .15 of sulphur.

British Pig Iron and Bessemer Steel in 1903.

The British Iron Trade Association has ascertained that the production of pig iron in the United Kingdom during the first half of 1903 was 4,378,998 tons, which is an increase of 282,520 on the make for the corresponding period of 1902, and is at the rate of 8,757,996 tons for the 12 months. In Scotland, Durham, and the North Riding of Yorkshire—the Cleveland district—there is a material increase on the output of the corresponding half of the previous year. In South Wales and in West Cumberland there has been a decrease, and in Lancashire, South Staffordshire, Derbyshire, Northamptonshire, South and West Yorkshire, Shropshire and North Wales, there has been an advance.

Statistics which have been included by the association from manufacturers show that the output of Bessemer steel ingots in the United Kingdom in the first half of 1903, amounted to 911,670 tons, which compares with 888,378 tons in the corresponding six months of 1902. The most notable changes, as between the two periods, have been an increase of 35,784 tons in South Wales, and of 3,937 tons in the Cleveland district, a decrease of 25,823 tons in the Sheffield district, and an increase of 12,548 tons in Staffordshire, Shropshire, etc.

The aggregate production of pig iron throughout the world last year is estimated at 44,557,991 tons, as compared with 40,889,358 tons in 1901, showing an increase of 3,668,633 tons. The United States contributed 18,003,448 tons, as compared with 16,132,408 tons in 1901—an increase of 1,871,040 tons.

The First Blast Furnace in South Africa.

The *African World* announces the erection of the first blast furnace in Africa. It is expected to be blown in about February next. The discovery of workable iron ore in the Lydenburg district of the Transvaal has lately been eclipsed by the location of rich iron ore deposits within a radius of a dozen miles from Pretoria. A furnace, which will have a capacity of 500 tons of pig iron weekly, is now being constructed, and in addition there is to be a complete installation of rolling mills for the production of rails and merchant sections, and black sheets for galvanising, etc. A steel-converting plant has also been arranged for. It is estimated that about 62,000,000 tons of iron are actually in sight.

Engineering Standard Committee Tests.

The third report issued by the Engineering Standards Committee is by Professor W. C. Unwin, and deals with the Influence of Gauge Length and Section of Test Bar on the Percentage of Elongation.

The report deals with the variation of percentage of elongation with different gauge lengths and sections of

test bar. It is based almost entirely on tests of steel plate test bars supplied by Mr. Colville, of the Dalzell Steel Works, Motherwell, N.B., and by Mr. Dick, of the Parkgate Steel Works. These tests cover a wide range of conditions, and no such complete information as to variation of elongation with the form of test bar has been previously available.

High-speed Tool Steels.

In a paper on high-speed tool steels, contributed by Mr. G. Borcherding to the Mechanical Engineers' Association of the Witwatersrand, it was remarked that the production of the modern high-speed steels with their wonderful capabilities was the outcome of numerous experiments and assiduous labour on the part of Sheffield's best men—a grand testimony that the old town kept apace with the times, and meant to maintain the first place amongst the steel centres of the world.

Doubtless, most of the gentlemen present would already have considered the question that in the near future it would be absolutely necessary to increase the shop engine power to meet the requirements of high-speed cutting tools.

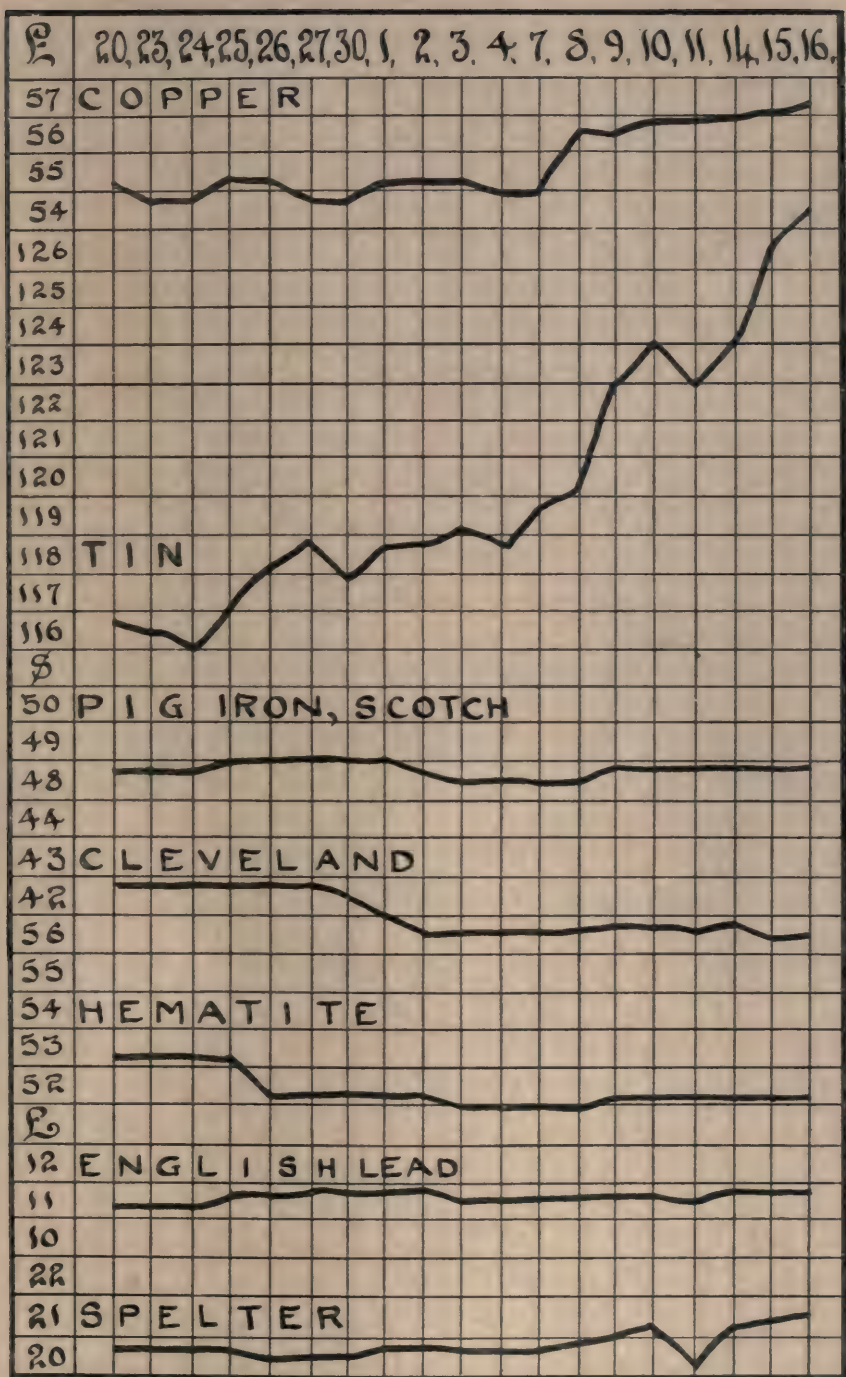
In fact, machine tool makers in England had fully grasped the situation, and in their catalogues already could be seen lathes with what appeared at first sight an abnormally large belt pull, and where the electric motor was embodied in the designs motors of a power apparently out of all proportion were fitted. Lathes of 12 in. centres, fitted with 6 h.p. motors, would, he thought, become quite common.

The general effect of these high-speed steels in the immediate future would be towards a revolution in the design of machines and machine tools; not only must the driving power be increased, but the saddle and slide-rests must be stiffened and the feed be gear-driven. Where the usual practice of $\frac{1}{32}$ in. and $\frac{1}{16}$ in. feeds now prevailed there would be $\frac{1}{8}$ in. and $\frac{3}{16}$ in. feeds.

According to statements made from various sides, the use of high-speed steels had already made it possible to decrease the cost of machine building from 25 to 33 per cent. At the same time, with the demand for machines that would give a cutting speed of at least 100 ft. per minute with a greater rate of feed, there was going to be plenty of work for draughtsmen and pattern makers, and an unlimited supply of firewood for the cupola until many of the patterns cherished at present were replaced.

The State Iron Foundry of Japan.

The *Financial and Economical Annual of Japan* gives some details of the expenditure for 1903-4 upon the State Iron Foundry. Since the establishment of the foundry a sum of about 15,000,000 yen (£150,000) has been disbursed, and the foundry has commenced the manufacture of rails on a pretty large scale. The enterprises, however, are not completed as yet, and in view of the probable great increase in the demand for iron, along with the extension of railways and the naval expansion, it has been decided to spend a further sum of 905,000 yen (£95,000) on the foundry in the current financial year.



THE HOME METAL MARKET.

Chart showing daily fluctuations between November 20th and December 16th.

POWER STATION NOTES.

The Genesis of the Large Gas Engine.

When Cockerill, Korting, Crossley, Orschelhäuser, etc., showed that it was possible to build gas engines of 500 and 1,000 h.p. and over, those who had so often said that gas engines of over 200 h.p. could not be made to run satisfactorily suddenly collapsed. The writer always had an open mind on the subject, but he must confess to being startled when, on the opening day of the Paris Exhibition of 1900, he stumbled against a giant machine, and was told by one of Cockerill's workmen that it was a *moteur à gaz*. Since then the large slow-running power-gas engine has become widely adopted for blowing purposes and for electric driving of iron and steel works it has also made great headway on the Continent. In England, where the idea of using power-gas originated, we seem to do little else but *talk* about it. What in the world are our iron and steel manufacturers waiting for?

Gas Engines Driving Alternators in Parallel.

One point which was somewhat uncertain in regard to large slow-running gas engines was, whether they could be depended on to drive alternators in parallel.

This has at last been answered in the affirmative at the Ilseder Iron Works, Germany. In this installation there are two 500 h.p. gas-driven blowing engines which take the place of the original steam blowers, and use only one-fifth of the gas necessary when generating steam. The bulk of the gas is thus available for electric power purposes, and six 1,200 h.p. three-phase generating units are being installed. The engines are of the Orschelhäuser type, having two pistons working in one cylinder and moving in opposite directions at the same time. A pump driven from the piston-rod forces air and gas at a few pounds pressure into the cylinder, and compression takes place when the pistons approach each other. Regulation is effected by the mixture of gas and air, so there is no missing of explosions.

The three-phase generator gives 10,000 volts, and the revolving mass has a flywheel effect of 2,500 foot tons, the irregularity factor at full load being $\frac{1}{300}$. There are two engines to each three-phase generator and the crank shaft is so arranged that either engine can be uncoupled for examination or repair.

Steam driven three-phase units are also in use, and it is found that the gas driven unit and the steam unit run perfectly in parallel even when one half of the gas engine unit is laid off. The gas engine governors are electrically controlled from the main switchboard and there is no trouble in synchronising. It may be mentioned as an additional interesting fact connected with this plant that the steel-rolling mills which are four miles away are entirely driven by three-phase electric motors.

Synchronising Cranks.

When C. E. L. Brown equipped the Central Station of the Frankfurt Municipality he installed single crank slow-speed engines, and to ensure them running in parallel, introduced an ingenious device for synchronising the engine cranks.

This is effected by an electric bell and a contact on the flywheels; the method naturally requires that all the engines should run at the same speed, and that this has been kept in mind when ordering extension sets.

So far as the writer is aware, Manchester is the only station in this country where the engine cranks are synchronised. The six units laid down under the Kennedy scheme are all the same size and speed, but the two units ordered by the late city engineer are much larger, and run at a different speed. It will be interesting, therefore, to see how the synchronising works out when these new units are ready.

Costs and Tariffs of Water Power Electric Stations.

In a recent book, by Martin, entitled "Les Distributions d'Énergie Électrique," there are some interesting figures on the costs of water-power electric stations. The large water-power station at Vizzola, in Northern Italy, for example, has a capacity of 22,000 h.p., and the capital expenditure has been £1,600,000, or, say, £72 a horse-power. The Société de Gouage à Lyon water-power station has a capacity of 27,000 h.p., and the capital expenditure has been £1,600,000, or £59 a horse-power. This latter company sells its energy at the rate of £4·8 to £14 per horse-power per annum. In the silk-weaving district of St. Etienne, in France, energy is sold at from £12 to £24 per horse-power per annum. In Switzerland the following are the tariffs for energy supplied from a water-power electric station: For motors using $\frac{1}{2}$ to 1 h.p. £12 to £10 per horse-power per annum; for motors using 30 to 50 h.p. £8 to £6 per horse-power per annum; for motors using 50 to 100 h.p. £6 to £4·8 per horse-power per annum.

Cooling Large Step-up and Step-down Transformers.

For large step-up and step-down transformers used on power circuits the question of cooling assumes considerable importance. There are two principal ways in which it may be effected—one is by air-blast and the other by oil circulation.

With air cooling the blower requires about 1 h.p. for each 200 kilowatts of transformer capacity, the air pressure per square inch being about $\frac{3}{8}$ oz. to $\frac{1}{2}$ oz. It is important that the temperature of the transformer must not be lower than that of the surrounding air, or condensation of moisture may take place.

With oil cooling it is important to take great care to have an absolutely neutral oil without any moisture in it whilst the insulation also must be selected for working in oil. The water coils for keeping the oil cool require about one gallon per minute for 500 kilowatts of transformer plant. 1,000 kilowatts would require about half as much again.

Ornate Chimneys.

As a rule the British public are long suffering in artistic matters, and yet at times there is a growl. Thus, not so long ago, there was an outcry about the ugliness of street hoardings, and as a result we have now those beautiful posters by Aldin, May, Cassier, and others. Chimneys are monstrously inartistic, and yet they are capable of being made really beautiful, fit to look upon, and at the same time useful as a means of viewing the surroundings. In Dresden, for example, the electric lighting and heating station is situated close by the Palace, opera-house and art gallery, and therefore a chimney of the ordinary type would have been wicked. The various authorities considered the matter with the result that the power-station chimney is so disguised as to be a really artistic feature of one of the finest views of Europe. Of course, this is a special case, but the writer commends the idea to authorities of cathedral cities and watering places, etc. where an ordinary chimney-stack would offend the eye.

Taking them as a body, electrical engineers are artistically reasonable and would not require much pressing. They are responsible for the overhead trolley-wires, it is true, but, after all, this is nothing compared with the horrible gas-works and gasometers with which our friends the gas people pollute the atmosphere and spoil our view. No engineer would have been capable, for such a monstrous eyesore as the gas-works on the banks of the Thames at Maidenhead, for example,

Vertical v. Horizontal Water-tube Boilers.

The chief requirement in a water-tube boiler is that the sedimentary matter shall be got rid of, or deposited before coming in contact with the portion of the boiler exposed to the hottest gases. This calls for good water and a large mud-drum, a great fault in water-tube boilers being that the mud-drum is far too small. Rapid circulation is a *sine qua non* for all water-tube boilers, and in this respect the vertical tube of the Stirling type, where each tube has full outlet into the drum, would appear to be better than the horizontal type where a number of tubes enter a single header having restricted outlet. The vertical tubes also allow steam to get away quicker, and they are not so liable to have smoke dust deposited on them, as is the case with the horizontal tube. Another very important requirement is that all parts should be circular or spherical, so as to admit of free expansion without straining. There should be no cast metal, and in this respect headers are certainly at a disadvantage.

One point in connection with water-tube boilers is that the direction of the circulation must never change. Now it is a well-known fact that in the horizontal water-tube type this does sometimes occur if hard pressed, and it results in the bottom row of tubes blistering by the pocketing of steam. As a result steam in large quantities is forced up the rear header, resulting in violent upheavals or geyser action in the steam and water drums, and heavy priming. Baffle plates are fitted over the discharge from the rear headers to try and obviate this trouble as much as possible.

In the vertical type the steam enters the rear bank of tubes where the heat of the furnace gases is lowest, and should any salts or other sedimentary matter be deposited the heat there is not sufficient to create a hard scale. The front bank of tubes, where 70 per cent. of the total evaporation takes place, thus escapes any scaling, and as each tube has a discharging outlet of its full area no pocketing of the steam can take place however hard pressed.

Flywheel Design.

The flywheels of slow-running engines are imposing, and have to be designed very carefully to meet the conditions of fluctuating loads, whilst at the same time not exceeding the safe limit. Accidents are happily much rarer than they were, and this is, no doubt, due to the greater skill which is given to the design of the flywheel, and also to the fact that most slow-running engines nowadays are fitted with an automatic stop motion.

In a cast-iron flywheel rim the safe tensile working stress is reached, at a maximum peripheral velocity of 100 ft. per second, which corresponds to about 80 ft. to 90 ft. per second on the mean circumference; the maximum stress due to centrifugal force being then about 1,000 lb. per square inch. If the rim is solid this means a factor of safety of twelve, or if link-jointed a factor of safety of eight, which is about the minimum. Flange-jointed wheels should not be run above 70 ft. to 75 ft. per second, whilst built-up steel wheels may be run at 130 ft. per second.

A good average value for the energy necessary to be stored in flywheels for electric lighting purposes is 2.9 foot-tons per electrical horsepower or for traction purposes 4 foot-tons. For a 500-kilowatt set with

two-crank engine, the rotating mass will weigh about 50 tons, for 1,000-kilowatt about 60 tons, for 1,500-kilowatt about 75 tons, for 2,000-kilowatt about 100 tons and for 2,500-kilowatt about 150 tons.

Speed Variation in Flywheels.

An important factor in designing flywheels for lighting or traction purposes is the value to be given to the co-efficient of speed variation allowable between the maximum and minimum limits. For ordinary lighting loads with continuous current dynamos the co-efficient is from $\frac{1}{100}$ to $\frac{1}{200}$. For alternators working in parallel on lighting loads $\frac{1}{200}$ to $\frac{1}{300}$, and for traction $\frac{1}{200}$ to $\frac{1}{300}$. Of course every maker has his own ideas on the subject, thus Messrs. Sulzer Bros. say $\frac{1}{200}$ for lighting and only $\frac{1}{300}$ for traction. This co-efficient is sometimes expressed as a certain number of electrical degrees of variation per impulse, thus a common value is 6 deg.—that is 3 deg. increase or lag from the mean. In an alternator with 60 poles driven by a two-crank compound engine, each pair of poles will describe 360 deg. in one cycle, so that the total number of electrical degrees described

is $\frac{60 \times 360}{2}$. At the same time the number of impulses per revolution is four, so that the number of degrees described in one impulse is $\frac{60 \times 360}{2 \times 4} = 2,700$.

The co-efficient will now be represented by $\frac{6^\circ}{2,700}$ or $\frac{1}{450}$, which is about right for good American practice.

Any one wishing to investigate this matter further cannot do better than consult a paper by Mr. Marshall Dourier in the Proceedings of the Institute of Engineers and Shipbuilders of Scotland.

The Unreasonableness of Governor Requirements.

It would be a good thing if some one thoroughly conversant with governors and their little peculiarities would go round and talk sense to some of the various consulting engineers. For by process of paraphrasing each other's specifications, and going one better each time, governor requirements have reached a point practically unattainable.

To attempt too much in governing is worse than to do nothing at all, because the finer the governing, or in other words the nearer one goes to the hunting point, the more likelihood of a serious accident. One frequently sees specifications calling for a control of speed within one per cent. of the normal from half load to full load, and when the full load is suddenly thrown off the increase is not to exceed 4 per cent. At the same time there must be provision for altering the speed up to 10 per cent. either above or below the normal whilst the engine is running. Even if it were possible to keep within one per cent. at any time the last requirement of a 20 per cent. variation of speed entirely gives the show away; it is a moral impossibility to have both. If the engines are driving alternators the points to be aimed at are, first to get them synchronised, then when in parallel to keep them in, and finally to see that each engine does its fair share of the work. Experience shows that an engine governing within 5 per cent. is more likely to attain these results than one governing within one per cent.

AMERICAN RÉSUMÉ.

NEW YORK, December 19th, 1903.

Modern Steam Yachts.

At the annual meeting of the Society of Naval Architects and Marine Engineers, held at New York, a paper was read by Mr. C. H. Crane of this city, entitled "Some Thoughts on the Design of Modern Steam Yachts." It was remarked that the American steam yacht had developed from the English designs, which from the first were sea-going ships rather than harbour boats. On this side of the water greater engine power (for higher speed) and more luxurious fitting were demanded, and the problem had been to meet these requirements without making the vessel less roomy or less sea-worthy than the English boats. Steam yachts were either ferryboats, to take the owner to and from his country place, or cruising vessels for making long tours. The development in steam-yacht building had been great in recent years. As many as 253 American-owned steam yachts, of 28,306 tons aggregate, had been built since 1890; this was over half the number at present registered in America. The plans of one of the most recent, the *Noma*, were given in the paper to illustrate how the requirements for comfort, speed and sea-worthiness had been met in a particular case. The vessel was 226 ft. on water line, $28\frac{1}{2}$ ft. in breadth, and $18\frac{1}{4}$ ft. deep, with a trial displacement of 1,035 tons and a speed of 19 knots. The engine was a four-cylinder, triple-expansion engine, running at 205 revolutions per minute of 4,200 i.h.p. Army water-tube boilers were used. The vessel had large bilge keels "which apparently did not interfere with her speed." It was stated that 22 per cent. of the displacement, exclusive of coal, water and stores, was occupied by machinery, while $37\frac{1}{2}$ per cent. was given up to outfit and joiner work.

American Society of Mechanical Engineers.

The most important business of the year, mentioned in the annual report of the Council of the American Society of Mechanical Engineers, was connected with the munificent purpose of Mr. Andrew Carnegie, who is a member of the Society, to give the sum necessary to make adequate provision for the accommodation of the four national societies of engineers, in an appropriate building, and for the Engineers' Club in another. Mr. Carnegie expressed his willingness to make the amount of his gift exceed a minimum of one million dollars, if that sum should be found inadequate to give the accommodation required for the present and the future needs of the organisations which he named. The four constituent societies named by Mr. Carnegie have appointed representatives, and from these representatives an executive committee has been formed, which since the adjournment of the Saratoga meeting has been formulating the details of the arrangement of the building, and another sub-committee has been considering the proper method for the management and control of such a joint undertaking. The report of these committees will be made public in the near future.

A New Type of Four-Valve Stationary Engine.

One of the papers at the New York meeting of the Society dealt with the construction and efficiency of a Fleming Four-valve Engine, directly connected to a 400 kilowatt generator.

Its nominal capacity is 500 h.p. at a speed of 150 revolutions per minute, 150 lb. pressure at the throttle and 26 in. vacuum. The cylinders are so proportioned as to give the high ratio of 1 to 7.33 following the

style advocated by Mr. Geo. Rockwood. No steam jackets are used, but a vertical tubular reheating receiver is placed in the steam passage between the two cylinders, steam being admitted to the high pressure cylinder through triple ported valves of the Corliss type working in chilled iron bushings, the governing being accomplished by a centrally balanced inertia shaft or wheel governor. This governor is so constructed that it is practically balanced in all positions, being made with two inertia arms, the centres of gravity of which move in harmony with each other about the centre of rotation, the balancing feature avoiding surging or violent action under all conditions of operation. This operates, by means of bell cranks, the steam admission valves of the high pressure cylinder only, and is so arranged as to decrease the lead at the earliest point of cut-off. The steam valves of the low-pressure cylinder are controlled by a fixed eccentric, so arranged that the cut-off in that cylinder can only be varied when the engine is not running, and remains constant under all conditions of load and pressure. The exhaust valves of both cylinders are of the Corliss type operated by a single eccentric through the medium of a peculiar arrangement of rocker arms and bell cranks. The author, Mr. B. T. Allen, describes a number of tests which he considers have fairly established the following principles:—

(1) That as a prime mover the elaborate dash pot or other accelerated cut-off devices used in present Corliss engine practice are unnecessary complications and unwarranted when comparing results.

(2) That the centrally balanced, direct acting fly-wheel device serves its purpose to better advantage than the indirect fly-ball governor.

(3) That there is better warrant for shorter strokes and moderately high speeds than for longer strokes and resultant lower speeds, notwithstanding the element of clearances.

(4) That self-lubrication without additional apparatus requiring attention to secure it, enters as an improvement in net efficiency, to say nothing regarding maintenance.

(5) That an engine of the described design, although of marked improvement in point of simplicity will rather exceed than equal the more elaborate practice heretofore established at normal load and excels comparable prime movers in a marked degree where the work is of a widely fluctuating character.

(6) That considering a resulting decrease in the cost of foundations, building, floor space, and, in electric practice, generators, due to better speeds, the design described determines its importance from the standpoint of investment.

What are the New Machine Tools to be?

This was the title of a paper contributed to the American Society of Mechanical Engineers by Mr. J. E. Sweet, who said he thought the machine-tool builders would admit that the machines must be re-designed in order to get even a fair share of the ultimate possibilities offered by the new high-speed tool steel. To the most of them would this mean anything but just to make the driving elements more powerful and the machines stronger—which was as much as to say everything had been all right, and all they needed to do was to change the strength and power? But had they been all right or half right? It could be shown by figures, he supposed (he knew it to be a fact by a trial with models), that a complete box was thirteen times more rigid against torsion and four times

more rigid against bending than the same amount of material was in the form of side plates and thin cross girts. It was probably from four to eight times more rigid than the cross-girt plan in any form, and yet in the case of lathes, the whole business of whose beds was to resist torsion, only one or two builders had had the courage or audacity to adopt the box form. Milling machines of the planer type were constructed like planing machines, seemingly without a thought but that the conditions were identical, while they were not. In the course of further remarks he said that to get the best out of machines, they not only wanted to be rigid and true, but the drive must be powerful. While manufacturing was going to call for many more simple machines—that is, machines to do one thing rapidly and well—the machines which would do a variety of work would be still in demand, for the sparsely settled sections of the country and the colonies would call for the country machine shop as of old.

Hints on Shop Construction.

Mr. F. A. Scheffler presented an ideal scheme for laying out new shops, covering a complete equipment for manufacturing on a large scale. The plan proposed was primarily designed for the manufacture of electrical apparatus, but the author remarked that it would be applicable to any other kind of manufacturing, where it was desired to have a number of shops which were to be easily accessible for business purposes and for the delivery and shipping of material. In the centre of the space available for the buildings the plan provides for an administration building, constituting the business, accounting, and sales offices; and on the second story, the draughting room. This building is octagonal, or hexagonal, whichever may be found to be most suitable for the purpose. In this case, it has been designed with a view of accommodating seven buildings, which radiate from each side of the octagon, and has one side reserved for the main entrance through the building. The end of each shop which is nearest to the administration building has its individual office for the foremen and shop clerks. This, it will be seen, is a very harmonious arrangement, as every shop is then but a short distance from the administration building, so that intercourse can easily be had between the drawing-room, offices and the offices of each shop. The general arrangement gives each shop plenty of yard room, which is also very essential; and travelling cranes, either worked by hand or power, could be located in the yard room between any two of the shops, for handling raw or finished material. A circular track around the administration building connected in front of each shop building by means of suitable turn tables, worked by hand or power, makes the distribution of material between the buildings very easy, and the distance the material will have to travel from any one building to another is comparatively short. At the extreme outer end of each building is another circular track, primarily to be used for shipping purposes, and the distributing of such material as may come in or go out over the connecting railroad lines. This track runs through the end of each building; and in such buildings where the machinery, castings, or other goods are to be handled, the heavier travelling crane in that particular building which should run the length of the shop, can easily unload or load the cars. This arrangement makes it possible to go into every shop without having a multiplicity of tracks and switches, thus cutting up the available yard room, as is usually the case in ordinary plants.

It is also possible, if there is sufficient ground available, to extend any one or all of the buildings, and still retain the best features of the design.

The New Steam Turbine Station at Newport, R.I.

The first vertical Curtis steam turbine installed in America is a 500 kilowatt machine at Newport, R.I.

The Newport station is one of several controlled by the Massachusetts Electric Companies, who operate about 900 miles of electric street railways and have already contracted for 33,000 h.p. in steam turbines. Three of these are 500 kilowatt machines, and will be installed at Newport, while the others will be placed in stations at Fall River and Quincy Point, Mass., and will be much larger units.

The Newport turbine, at present in operation, runs at 1,800 revolutions per minute, taking steam at 140 pounds pressure at the turbine nozzles. Alternating current of 2,500 volts is generated. The turbine is 7 ft. 8 in. in diameter at the base, and 12 ft. 6 in. high. The station plans call for four turbines in all.

Automatic Machine for Track Laying.

Mechanical improvements have made it possible to construct railroads in the United States with a speed that would have seemed impossible a decade ago. An instance of the development in this direction is given in a recent issue of the *Cincinnati Enquirer*, which describes a peculiar piece of mechanism—that is, laying the tracks of the Cincinnati, Richmond and Muncie railroad at the rate of two and a-half miles a day. This track-laying machine automatically and accurately lifts the ties and rails into position, the most drudging labour in all railroad construction. It also furnishes the motive power for its own construction train.

There were stretches of roadbed over which the construction train moved at a rate of over 1,800 ft. an hour. The machine utilised was one which differs in many essentials from that which has been used in other sections of the country. One of the most interesting features is the manner in which the material is delivered to the roadbed and the comparatively few men required for the different operations, as the ties and rails are lifted and moved from the cars on which they are carried to the roadbed, being connected and spiked while the train is in motion.

An endless chain carrier puts the ties in position, while a crane suspended upon a steel truss lowers the rails in advance of the construction train. In this manner the engineers in charge of the road hope to run into Cincinnati many weeks earlier than they could otherwise have done. The machine weighs fifty tons, and was made in Scranton, Pa., U.S.A. It is the only one of its kind in existence, and its inventor, Mr. Hurley, who accompanies the machine, spent ten years in perfecting it and thousands of dollars on models before success crowned his efforts.

The work done upon the Cincinnati, Richmond and Muncie road demonstrated that a force of about forty competent men were all that were required to operate the machine to its fullest capacity, and that when conditions are favourable over three miles of track a day of ten hours could be put down without difficulty, while an average of over two and one-half miles could be recorded. The gearing on which the material is conveyed from the platform through the machine can be operated at the same rate of speed at which the train is moved or its speed can be doubled. The weight of the rails handled include the heaviest used for American standard-gauge construction.

SOUTH AFRICAN RESUME.

JOHANNESBURG, December 10th, 1903.

Mineral Output of the Transvaal.

The following tables have been compiled from the Official Mining Statistics issued from the Government Mining Engineers' Department, and show the results for the third quarter of 1903.

GOLD.

Month.	Yield in ozs. fine.	Value in £ sterling.
July	252,944	1,074,432
August	273,591	1,162,141
September	276,787	1,175,716
Totals	803,322	3,412,289

SILVER.

Month.	Yield in ozs. fine.	Value in £ sterling.
July	30,343	3,123
August	33,498	3,493
September	32,668	3,400
Totals	96,509	10,076

COAL.

Month.	Tons.	Value realised at pit.
July	219,690	85,179
August	213,064	82,357
September	204,537	80,026
Totals	637,291	247,562

DIAMONDS.

Month.	Carats.	Value.
July	16,793	23,667
August	1,751	22,700
September	20,329	28,138
Totals	53,873	74,571

A Rand Bore-hole.

Of the numerous bore-holes which have been put down with diamond drills to locate the reefs on the deep level claims of the Witwatersrand one of the most easterly is that recently completed by Messrs. Lewis and Marks on the farm Grootvlei, about thirty miles due east of Johannesburg.

The record of the core gives a good idea of the general nature of the strata overlying the reefs.

Surface to 903 ft.

931 ft. to 1415 ft.

2084 ft. to 2153 ft.

2153 ft. to 2373 ft.

2616 ft. to 2760 ft.

2933 ft. to 2949 ft.

2996 ft. to 3414 ft.

Dolomite.
Quartzite.
Kimberley Series of Reefs.
Quartzite.
Slate.
Quartzite.
Slate.
Quartzite.
Bird Reef Series.
Banded Slate.
Quartzite and Slate.
Amygdaloidal Diabase.
Quartzite.
Modderfontein Series of Reefs.

Van Ryn Series (now recognised as part of the Main Reef Series) in the following order:—

Leader 9 inches.

Leader 4½ "

Leader 3½ "

Reef 21 "

The Tinfields.

The discovery of tin in the Transvaal has been followed up during the last few months by prospecting work undertaken by the Transvaal Tin Mines Syndicate with the result that the property has been taken over by one of the leading financial houses with a view to systematic prospecting and subsequent flotation, if the former operation justifies the latter.

Several tin-bearing lodes have been found which it is proposed to prove by means of an adit, driven in approximately at right angles to their strike in order to show whether the lodes continue in depth and also whether it will pay to work them.

The property is situated on a Government farm named Oshoek adjoining the Swaziland border, and as a matter of course a large quantity of ground in the neighbourhood has been acquired or taken under option for prospecting or speculative purposes.

A limited company has been formed to prospect and develop the adjoining farm, Bettysgoed, into which the same tin-bearing lodes are presumed to run.

Natal Harbour Department.

An order has just been given out for the lighting of the Suction Dredgers *Curlew*, *Ibis*, and *Water Rat* by electricity, to enable them to work by night. Tenders were informally called for, and Messrs. Greenwood and Batley, Ltd., of Albion Works, Leeds, through their direct representative at present in Durban, were successful in securing the order.

The plant which will be supplied consists of three complete sets of 7 b.h.p., 44 kilowatt, de Laval Patent Turbine Dynamos, arranged to work either condensing or non-condensing, at a steam pressure of 50 lb and 110 lb. per square inch, two being fitted for the latter pressure. The voltage of the dynamos will be 110, and the capacity of the sets is equivalent to about 140 8-candle power incandescent lamps.

The wiring of the dredgers will be done departmentally, under the supervision of Mr. G. Stobie, A.M.I.E.E., the Harbour Electrical Engineer, who has great confidence in the nature of the Steam Turbine. The installation will be completed early in 1904.

GERMAN RÉSUMÉ.

BERLIN, December 21st, 1903.

High Speed Trials with Electric and Steam Locomotives.

In the course of the Marienfelde-Zossen high speed trials, the safety of working of the current collectors was particularly remarkable even for the highest speeds. Many runs at 200 and more kilometres per hour were performed by both cars, speeds as high as 208 kilometres being, for instance, reached on November 25th. Special attention has been paid to braking and inertia tests. By increasing the braking pressure, the braking distance has been more and more reduced. Moreover, a new device has been tested, preventing automatically the wheels from being braked at decreasing speeds by drawing air off from the braking cylinders. Trailing experiments have been performed on six-axle sleeping cars, connected to the high-speed cars, it being shown that trailers up to speeds of 160 kilometres will run rather smoothly, material oscillations being observed only at speeds as high as 180 kilometres.

These experiments having shown that existing permanent ways, with careful construction and supervision of the track, are capable of standing much higher speeds than those now in vogue, even without any specially designed cars, the Prussian railway authorities have decided on undertaking on the same Marienfelde-Zossen military railway some further experiments as to the performance and behaviour of several types of locomotives. It is intended to reach speeds as high as about 140-150 kilometres per hour, and as the locomotives ordered for this purpose are now complete, it is anticipated that these experiments will be started in a very short time.

Additions to the Berlin Elevated Railway.

Some further developments of the Berlin "Hochbahn" lines have been under consideration for some time, and according to information just to hand, a provisional prolongation of the Elevated Railway from Potsdamer-Platz to Hausvogtei-Platz appears to be definitely decided on, the beginning of the work being anticipated for next spring. A further project has been submitted to the superintending authorities in regard to an additional line from the Charlottenburg-Knie station as far as Wilhelms-Platz, Charlottenburg, and it is safe to state that the construction of this line will also be commenced in the course of next year. On the other hand, as regards a contemplated rectilinear prolongation of the Charlottenburg line as far as Westend, a Charlottenburg suburb, negotiations are not yet concluded.

The Siemens and Halske Rapid Type Printing Telegraph.

A novel kind of rapid type-printing telegraph is being developed and has just been brought out by the Siemens and Halske Company. The apparatus belongs to the class of the so-called automatic telegraphs (Pollak-Virag system) where the telegram is prepared by a typewriting device piercing for each letter to be telegraphed a given hole or set of holes in a continuous paper ribbon. The latter on being drawn through the rotating telegraphic transmitter will automatically throw corresponding current impulses into the circuit. As the Siemens apparatus is capable of telegraphing 2,000 letters per minute on the same line, whereas each official even with the

best of apparatus cannot transmit any more than 200 to 300 letters in the same interval of time, it will be possible to send the telegrams transmitted by a large number of officials through the same line. In the Siemens apparatus, two holes are pierced in the paper ribbon for each letter, the letter being itself printed in plain printing characters immediately above so that the perforated ribbon contains the telegram in distinctly readable form. Moreover, the public itself will be able to take charge of the perforating, transmitting the prepared ribbons to the telegraph office.

In the receiving apparatus, the ribbon arrives at the same speed ready for sticking on telegram forms, containing the telegram in plain printing.

In order to ensure this printing of 2,000 letters per minute, without any mechanical delicate apparatus, the electric spark is resorted to. A disc where the various letters are cut out as in a pattern is rotated at a speed of 2,000 turns per minute between a spark gap and a continuous ribbon of photographic paper. Whenever a spark passes in the gap, a silhouette of the letter happening to be in front of it is projected on the paper ribbon. It should be noted that the spark must be produced with an accuracy as high as one 40,000th part of a second in order to have the proper letter appear at the proper place. The paper ribbon next passes beneath some sponges impregnated with developing and fixing liquids, the photographic process requiring only nine seconds, so that the ribbon is delivered ready printed.

The problem of causing the spark to be produced with the utmost accuracy at an instant accurately given in accordance with the current impulses transmitted from the sending apparatus, was solved by utilising to a high extent the property of electric condensers of being charged and discharged in very short intervals. The mechanism of the apparatus has hence been so simplified that the receiver, apart from the photographic device, is embodied simply by a shaft driven by an electromotor on which in addition to the above mentioned type disc only some brushes are mounted sliding over contact discs. In addition there are five relays of special design, the tongues of which will follow the rapid impulsions without any difficulty and at a sufficient speed. A special rather ingenious device causes the receiving apparatus to perform in a given time accurately the same number of turns as the transmitter giving off the current.

Experiments for which the Imperial Postal Department had lent some lines have shown the practicability of the apparatus for transmissions over great distances. Dr. Franke, Dr. Thomas and Mr. Ehrhardt have, through their assistance, contributed to the design of the apparatus.

The Berlin Teletyping Central Station.

On October 1st a most valuable addition to the Berlin telephone, with its nearly sixty-eight thousand subscribers, was made, when the "Fern-drucker Centrale" was opened to public service. Telephones, which only render words as they are spoken, are frequently inefficient for business purposes; in addition to a correct transmission of a communication, there will, in many cases, be necessary an acknowledgment in writing of this transmission. On the other hand, there is the liability of telephonic

conversation to be overheard by a third party and finally the person rung up on the telephone may happen to be absent, when his return will have to be waited for and much time be lost. In all these cases, the new teletyper service is intended to afford efficient means of communication.

The teletyper as constructed by the Siemens and Halske Company is a type-printing telegraph, similar to the well-known Hughes type printer and the Baudot telegraph. The main distinctive feature from former apparatus is, however, the fact that the latter moving freely, the synchronism of the instruments established on the same line had to be obtained by the skill of the operator, whereas the operation of the new apparatus being nothing else than a typewriter may be learned by anybody in the shortest possible time. The key-board of the teletyper is similar to that of an ordinary typewriter, comprising four superposed rows of seven keys each, out of which twenty-six are each provided both with a letter and a figure or sign of punctuation. As regards the remaining two keys, one serves as beginning or letter key, whereas the other, bearing the inscription "Zahl," is used as figure or punctuation key. By striking either of these keys, the type-wheel of the printing telegraph is adjusted either for letters or figures in a manner similar to the Hughes apparatus. Both of the apparatus connected by a line may be used either as sender or as receiver without any special preparation or switching being necessary, both of them being automatically and simultaneously operated as soon as the first white key is struck, when the apparatus in question becomes a sender, and all is ready for use.

The type-wheel bears on its periphery, in one circle, the letters, and in another parallel circle the figures and signs of punctuation. On acting on the shift key the type-wheel is shifted automatically on its shaft so as to place the row of signs concerned above the printing surface of the paper ribbon. By acting on an ordinary key on the other hand, the type-wheel is rotated as far as to bring the type in question in front of the paper, when the latter is pressed against the wheel and receives the printing, to return downwards again instantaneously and to be moved as far as the interval of two letters, so as to be able to receive the following sign. This process will occur simultaneously in both of the apparatus connected by the line, *i.e.*, both in the transmitter and receiver, being automatic in the latter, no matter whether there is or is not somebody operating the receiving apparatus. In the case of the owner of the apparatus being absent, the telegram may be read on the paper ribbon on his return. The electric printing telegraph will thus give two perfectly similar records of the same telegram; one on the sending and the other on the receiving apparatus.

As soon as the beginning key is pressed downwards, the circuit of the transmitting apparatus is completed, resulting in a switching roller being set rotating, throwing electric currents of alternating directions into the printing telegram circuit and through the line-relays connected to the apparatus; the latter will insert both in the transmitting and receiving apparatus local currents which by means of so-called relay-magnets produce the rotation of the type-wheel from the initial position identical in all the stations. Now, in the case of a letter key being pressed downwards, a peg attached to the other end of its lever will strike against the rotating switching roller brush, stopping the latter and thus the type-wheel of the printing telegraph. At the same time the type levers of both apparatus being attracted will cause the corresponding letter

to be printed. As long as the key is pressed downwards, the type-wheels are incapable of moving any further, thus enabling the transmission to take place at any desired speed. After a telegram is transmitted, both the transmitter and receiver will be switched out automatically at a certain position of the type-wheel, the apparatus thus being stopped automatically. Twelve accumulator cells built into a box serve as working battery. The tension of about twelve volts as obtaining in the line circuit is so low as to exclude any possibility of an inductive influence of printing telegraph circuits on neighbouring telephone circuits.

The advantages afforded by the printing telegraph as compared with telephone and present telegraph systems will be evident. Like the telephone, the printing telegraph may serve for a direct communication between two persons over any distances, but for the additional advantage of any hearing-mistakes or other misunderstandings being excluded by the double and simultaneous reproduction of the communication in printing. As above stated, the printing telegraph will, at the same time, make it impossible for a third person to overhear communications which is even possible in the case of the Morse telegraph. This is, therefore, the only means of communication enabling despatches to be kept strictly private.

The central station just opened is fitted with a switch-board having indicators and catches for one hundred subscribers. Sixteen connecting strings allow of thirty-two subscribers being simultaneously connected, so as to enable a simultaneous communication between a third of all the subscribers in the case of the switch-board being complete. As soon as a subscriber presses down the calling key of his teletyper, the official in charge of the indicator board of the central station will be advised by the indicator board of the subscriber in question dropping and an alarm being rung, when he will put himself in communication with the caller, in order to ask for the desired connection, and connect both subscribers so that their apparatus are ready for direct communication. This shows then similarity of service with telephone service and the great advantage of any two subscribers communicating directly. There is, however, in addition the possibility of connecting any desired number of subscribers to the same printing telegraph so as to transmit the same communication simultaneously to all the subscribers.

Similar telegraphic services from one central station to a certain number of subscribers simultaneously by a so-called "ticker" have for some time been in use in New York, London and Paris. A similar service has been in operation also in Bremerhaven, Germany, for transmitting ship telegrams from one central station to one hundred subscribers in different places. The central station just opened in Berlin is also intended in addition to the mutual communication between the subscribers, to transmit similar informations to a certain number of subscribers, limiting the service at first to Exchange telegrams. The same system of communication could be employed for transmitting telegrams from a central telegraph office such as Reuter's to a certain number of newspaper offices. In addition, the above central station is intended to secure communication with the central telegraph office for transmitting or receiving telegrams through the State telegraph. The new system has been in use for some time with great industrial concerns, such as the Berlin Allgemeine Elektrizitäts-Gesellschaft, and the Siemens and Halske for communication between their various departments.

MINING NOTES.

The Efficient Crushing of Gold Ore.

A very complete paper presented by Mr. R. A. Kinzie to the American Institute of Mining Engineers describes the Treadwell Mines of Douglas Island, Alaska.

The features that have made the Treadwell Mine justly famous are the mining and milling at a profit of ore that does not yield an average of more than 2 dols. per ton.

The crushers are located in the head-frames of the various mines, and are of the gyratory type. When the ore is hoisted out of the mine it is spilled by self-dumping skips on a grizzly formed by 1-in. by 10-ft. pieces of iron, bolted together by 1-in. iron bars, and placed 2-in. apart by disc-shaped pieces of cast iron. The over-size from the grizzlies goes direct to the crushers, and the under-size passes through and falls into the ore-bins situated directly beneath the crushers.

Too much stress, says Mr. Kinzie, cannot be laid upon the great effect of efficient crushing as related to the duty and output of a stamp-mill. This is particularly true on the island, where the crushing capacity is in excess of the demand and where there is abundant water-power which costs practically nothing. During the past year the duty of the mills has been increased over 1 ton per stamp in 24 hours, and without a doubt, 50 per cent of this increase has been caused by setting the crushers to break the rock 20 per cent. smaller than before. An efficient crushing-plant for mines similar to the Treadwell would consist of four Gates-crushers arranged in pairs, one above the other, the upper to be of such a size that they would receive rocks 18 by 36 in., and the lower to turn out a product not larger than 1.5 in. in diameter. The rock when hoisted would be dumped on grizzlies with 5-in. spacing bars between: the over-size going to the upper crushers and the undersize falling on a second grizzly with bars set 1.5 in. apart—over-size going to the lower pair of crushers and under-size passing into the storage-bins. The product from the upper pair of coarse crushers to be spilled on the grizzly with bars 1.5 in. apart, the over-size going to the lower crusher and the under-size and crushed product from the lower crushers falling into the bin. If the above method were used it would do away with a great deal of the bull-doing and rock-breaking in the mines, making a very appreciable reduction in the cost of mining.

Machine Drilling at its Best.

Considerably over 75 per cent. of the ore mined from the Treadwell has come from the open or surface pits. Machine-drilling is seen at its best in these pits. The 3½-in. diameter Ingersoll-Sergeant drills, set on tripods, are used in all the pits at present. The average number of feet drilled per machine in 10 hours is 36.35. The holes are drilled to an average depth of 12 ft., and each machine will break 69.69 tons of ore per shift of 10 hours. When the pits were smaller, and the difficulty of setting up was not so great as at present, the average number of feet drilled was much higher, and the breaking capacity

of a machine-drill was from 150 to 200 tons of ore per shift of 10 hours. The pits are worked by drilling and blasting the ore from a series of benches or terraces around the chute-raise as a centre, and when the ore is blasted the broken rock rolls down to the bottom. The small pieces are then broken by sledges, and the larger ones by placing sticks of powder on the surface of the rock, tamping with a little fine dirt, and blasting. For blasting holes, No. 2, or 40 per cent., dynamite is used, while for "bull-doing" No. 1, or 70 per cent., is the best.

When the rock has been broken to the required size, it is drawn off, through the raises and chutes described above, into cars. These cars are hauled to the station ore-bins by horses, or by endless-rope haulage, where they are dumped. The ore is then loaded into skips, hoisted to the surface, and handled in the usual manner.

Transvaal Coal.

Returns issued by the Mines Department show that during the last three months a check has been given to the output of coal in the Transvaal, and that the output of the year will fall short of expectations formed about three months ago. The principal cause of this shortage appears to be the lessened consumption on the railways.

Chinese Copper and Antimony.

A correspondent of the *Engineering and Mining Journal* points out that China may in a few years be in a position to ship enormous quantities of copper at less than half its present cost of production. China, independent of hundreds of miles of railways now in operation, in course of construction, and provided for, is covered by a complete network of rivers and canals, with a system perfected by centuries of use. The question of transportation would probably never act as a bar to the workings of any property. Labour is to be had in unlimited quantities, good and steady, at rates per month less than are usually paid per day in other countries. Coal of good quality is there in enormous quantities, with other requirements for mining and smelting, such as food supplies cheaper than in any other place where mining is now conducted. Within five years the working of a few antimony mines in the province of Hunan was commenced under Government control, and were it not for this control, the offerings from China would swamp the market; as it is, prices of refined antimony have been forced down over one-third and Chinese antimony ores are offered of good quality at low prices. The mines are worked by hand labour, with crude tools, and no machinery is used. The ores as brought to the surface, are sorted by women and children and are broken, where necessary into small pieces, hand-culled and dressed. In this way the ore for export and for sale is practically pure. The rejected ores are smelted into crude antimony by a primitive method, with great waste.



OPENINGS FOR TRADE ABROAD.

BRITISH INDIA.

ATTENTION is called to the fact that of late years small screw-cutting lathes have become very popular among Indian craftsmen, who seem only to learn the use of the slide rest, and never that of the hand rest. The screwing tackle of the English country blacksmith of 50 years ago would perfectly suit the ideas of the Indian workman.

ORANGE RIVER COLONY.

It is reported that there is every prospect of small flour-milling plants being sold in the outlying districts out of reach of the large mills. There is no import duty on machinery.

GERMANY.

It is announced that work is soon to be begun upon a steam railway line between Adorf, Saxony, and Rossbach, Bohemia.

SPAIN.

Two prizes are offered for a complete plan and estimate for establishing a water supply for the town of Ferrol. The plan must be sent in within seven months to the Secretariat of the "Ayuntamiento" of Ferrol. The first prize is to be at the rate of about £24 per kilometre to be covered by the water-pipes from the place of supply to the town boundary, and the second prize is to be about £119.

Tenders are called for the public lighting of the town of Riveira for twenty years by electricity. The competition will turn on the annual amount the contractor is willing to accept, the upset rate being 2,616 pesetas, or or £77, for 200 lights.

A concession for 99 years without any subvention from the Government has been granted to the Minera del Moucayo Company for a narrow-gauge railway from Castejou to Olvega.

Tenders, which are to be presented up to 5 p.m. on January 8th, are in demand for the work of the bridge over the River Cazin, on the high road from Bailen to Malaga, in the province of Granada, at the upset price of 79,382.79 pesetas, or about £2,356. A provisional deposit of 4,000 pesetas, or about £118, is required to qualify any tender.

Tenders are required in Madrid for the execution of the works of the bridge over the River Tuerto and the crossing of La Baneza, on the high road from Rio Negro to that from Leon to Caboalles, in the province of Leon, at the price of 237,605.88 pesetas, or about £6,954. Last day for upset receiving tender, 15th January.

RUSSIA.

The following railways will be constructed by the State in 1904:—Kherson-Nicolaeff, with a station in the town of Nicolaeff; and Grodno-Zelviany. In 1905 a line from Novo-Sénaki on the Trans-Caucasian railway to Soukhoun. Plans are to be drawn up for the laying down of a railway to connect Petrozavodsk with the Mourman coast *via* Kémi. Veltén and Guillaume Company have been asked to estimate for the laying of a telegraph cable, 82 versts long, across Lake Baikal. The depth of the lake is said to vary between 600 and 900 sagènes. The cable would be similar to the Atlantic cables. A despatch has been received at the Board of Trade, pointing out that there will be an opening on a large scale for refrigerating plant, cooling apparatus, and ice-making machinery in the slaughter-houses which it is proposed to erect at Warsaw. Another despatch reports that the Russian Government has decided to construct an electric railway between Sevastopol and Yalta, to pass, *via* Balaclava, Bida, Aloupka, and Livadia.

CUBA.

Inquiries have been made through the Board of Trade for the names of manufacturers in this country of machinery for extracting the fibre of the henequen or of other textile plants, like sisal, ramie, etc., in their raw condition, as well as for the manufacturing of mats, hats, sails, bags, etc., of the same fibres.

ARGENTINA.

The Congress will deal with the revised project in regard to the construction of a dry dock at San Juan, and the construction of a railway from Rosario to Puerto Militar.

NOTABLE BRITISH PAPERS.

A Monthly Review of the leading Papers read before the various Engineering and Technical Institutions of Great Britain.

SCREW PROPULSION FOR WARSHIPS.

IN the course of an important paper on Screw Propulsion for Warships, read before the Royal United Service Institution, Fleet-Engineer G. Quick, R.N. (retired), remarked that :—

Forty years of practical experience, and thirty years of model experiments had failed to produce any substantial improvements in ships' propellers; but nevertheless, within the last few months we have had the speed of the *Drake* and *Hyacinth* increased by one knot, and the speed of the "County" class increased to 23·7 knots, which would have been impossible if the generally accepted theories of ship resistance at high speeds had been correct. Great as this increase in maximum speed has been, I am convinced that a further series of experiments will prove that even still greater maximum speeds can be obtained from all our modern ships by the simple and inexpensive plan of fitting them with new screws. The cost of such trials and of fitting new propellers would be infinitely small compared with the great advantages to be gained both in maximum speed and in economy of fuel.

The enormous value of the Admiralty improvement of the *Drake's* screw must be apparent to all. But this improvement having been effected, the question arises: Is it possible to make a further improvement in the propellers of those ships so as to drive them at still higher speeds with the same horse-power? Experiments alone on one of these vessels can show exactly how much the maximum speed of those ships can be increased, but I venture to say that by some considerable changes in the present form of the screw propellers there is every probability of an increase of speed of at least one knot being attained with the same maximum horse-power—or, in other words, that the speed of the *Drake* class can be increased to twenty-five knots with the present boilers and engines, and with practically the same coal consumption as at present. To effect this, the proposed new screws would have to be more efficient than the large screws of the *Drake* to the extent of 4,800 i.h.p. And as the large screws of the *Drake* gave a speed equivalent to an increase of 10,500 i.h.p. over the original small screws, I do not consider that twenty-five knots is an extravagant estimate for the speed of the *Drake* with propellers still further improved in design.

Incidentally the author said he did not admit that the tank experiments which are being made in this country and abroad have the same value as experiments made on full-sized ships in deep water. Tank experiments on models indicate the direction in which investigations should be made, but they are not to be relied on in all cases for the formation of hard and fast rules for the design of all classes of propellers. The most valuable contribution which has been made of late years to the solution of the resistance of ships is the discovery of the influence of the depth of water on the resistance and speed of ships.

In the course of further remarks the author said: I do not claim that any definite laws can be deduced from my model experiments on the reduction of the resistance to rotation of blade surfaces, curved and

receding, such as I propose, but so far as my experiments and speculative investigations go, they show that by reducing the width of the blades very considerably near the boss, and by curving and receding the blade surface as described, the resistance to rotation may be so diminished that from thirty to fifty per cent. less power will have to be expended on rotation only and that the power so saved from reduced resistance to rotation may be expended :—

1. In giving a higher number of revolutions to the curved bladed screw of pitch, diameter, and area, equal to the ordinary screw with radial blades, and a higher speed of hull; or,

2. That the screw with the curved receding blades, if of the same diameter and pitch, may have the width of the end of the blades very much increased without the revolutions of the engines and the maximum power of the engines being increased or reduced thereby, and that such increased area at the end of the blades, and reduction of width near the boss would lead to a considerable increase in the maximum speed of the ship and large reduction in the number of revolutions required per minute to obtain any required speed; or

3. For very long ships of fine lines these curved receding blades, with wide ends, may have the same diameter and total area as ordinary blades, but a higher pitch-ratio in order to obtain high speed of hull with a moderate number of revolutions per minute. If in this case it were found that insufficient revolutions, i.h.p., and speed were attained, the question whether the pitch ought to be reduced, or the blades reduced in diameter, must be ascertained from calculations made on the results obtained by that particular ship and propeller.

The total changes in screw propeller design I propose to effect are considerably wider than those I have brought to your notice at present; and here I would point out that a change of propellers can be effected at less cost than any changes in connection with boilers and engines, and that such changes cannot give rise to any trouble after they have been adopted. Every saving of power and increase of speed by the screw propeller which may be effected is of the most far-reaching value in war and commerce, and cannot introduce any countervailing disadvantages, such as sometimes attend the introduction of new forms of engines or types of boilers.

Here I must state that I am aware that, in proposing to increase the width of the end of the blades, I am reverting towards the earlier form of blade—and abandoning the fashion introduced by the late Mr. Griffiths. But I must point out that the conditions now are different from what they were forty or even fifteen years ago; also that the locality of the propelling surface is of as great importance as the proportion of the area of that surface to the maximum i.h.p. For one square foot of surface at or near the periphery is equivalent to at least eight square feet at or near the semi-radius of the blade. Thus it is possible to have propeller blades of 100 square feet of area arranged with narrow ends and great width near the boss, and yet making more revolutions with a given h.p., and giving less speed and efficiency than another propeller of the same pitch and diameter, and less total helicoidal area, but having greater width at the ends of the blades and less width near the boss.

It has required many years of scientific research and hundreds of trials to bring the ordinary radial-surfaced screw to its present condition of efficiency.

and I therefore trust that the system I propose may have a few preliminary trials in order to develop its highest possibilities. A large number of trials of vague, rule-of-thumb changes, is not desired, and is not necessary, but certain developments should be proceeded with cautiously, according to the indications progressively given by the earlier trials which may be made by this propeller.

MULTIPLE PROPELLERS.

Multiple propellers were employed nearly fifty years ago, and the turbine system is bringing them again into notice. For nearly thirty years I have advocated triple propellers, *with three isolated engine-rooms*, in order to obtain as much security as possible for some portion of the propelling power during battle. There are, in my opinion, as a mere sea-going engineer, a dozen good reasons for the adoption of triple propellers in large high-speed ships for every single reason urged against it. I cannot consider that certain foreign Powers, such as Russia, France, and Germany, have been hasty and injudicious in adopting triple propellers for their large warships. Germany, alone, has nearly forty large warships built and building with triple propellers, and I hope that we may soon give triple propellers a trial in some very large ships. Admiral Melville, of the United States Navy, has so admirably stated the case for triple screws that I have nothing to add to that which he has said.

The introduction of triple screws in vessels where there is an installation of over 20,000 h.p. is just as logical a development of machinery design as the introduction of twin screws was a generation ago.

EXPERIMENTS ON THE EFFICIENCY OF CENTRIFUGAL PUMPS.

IN this paper, read before the Institution of Mechanical Engineers, the author, Mr. Thomas E. Stanton, D.Sc., describes a number of experiments which he made in the Hydraulic Laboratory of University College, Bristol, in order to obtain, if possible, further information on the losses of efficiency in these pumps, and the means of reducing them.

The author's conclusions were as follows :—

1. In high-speed wheels, *i.e.*, wheels in which the velocity of the tips of the vanes exceeds 40 ft. per second, the effect of moderately recurving the vanes at the outlet is beneficial (especially when the water is discharged into a free vortex), the curvature being such that the velocity of flow of water through the wheel is uniform.

2. Wheels which discharge the water into guide passages give a higher efficiency than those which discharge the water into a free vortex, this advantage being more marked in the case of wheels with radial vanes than in the other type.

3. The number of guide passages should be not less than four, and the areas at inlet should be such that the velocity of flow into the passages should be equal to the velocity of discharge from the wheel, to avoid losses from sudden changes of velocity.

As regards any modification of the existing design of centrifugal pumps, the author ventures to suggest that increased efficiency and considerable economy in material and space occupied would result in the adoption of a high-speed pump driven direct from the motor and designed on the principles laid down above. For dealing with very large quantities of water at a low lift, no doubt

the present slow-speed pump driven direct from a steam engine has great advantages, but for supplying moderate quantities of water at high—or moderately high lifts—the high-speed motor-driven pump is very suitable. When the simplicity of construction and small cost of centrifugal pumps is considered, it seems remarkable that the use of them should be so limited. This is perhaps due to the impression which has till recent years prevailed that these pumps were useless at other than quite low lifts. Now that their adaptability and satisfactory working at high lifts is being recognised, there seems every reason to suppose that they will come into use in many cases where reciprocating pumps have hitherto been solely employed.

THE USE OF COPPER FOR STEAM FITTINGS.

ACCORDING to Mr. W. E. Storey, who read a paper on "Some Applications of Copper in Engineering Practice" at a meeting of the Manchester Association of Engineers, an impression prevails that as a material for use in the construction of pipes and vessels in connection with steam service, copper at the present time is under a cloud.

The conditions under which it was now frequently applied had increased in stringency, particularly along the lines of higher pressures and temperatures, and largely because of a lack of progress in design to meet these conditions, due to a want of knowledge of the possibilities and limitations of the metal. He hoped to be able to show how by careful attention to design on the part of the engineer, and to production and treatment on the part of those who combined to supply him with either the materials for his own manipulation, or the finished copper products, the advantages which undoubtedly attended the use of copper and its alloys might be safely utilised.

The main claims that copper had to consideration, and in fact to pre-eminence amongst the metals of commerce, so far as its special qualities were concerned, were (a) its high electrical conductivity, (b) its capacity of conducting heat, (c) its extreme ductility, and (d) its resistance to corrosion. On the first of these he had nothing now to say; the second and third taken together might be said to be of extreme importance to engineers; while the last also had its interest, for such uses of copper as the manufacturing chemist, the calico printer and bleacher. Copper gained its place in the regard of engineers because of its unequalled power of transmitting heat and its great ductility, which enabled it to be worked into intricate forms with ease to the operator and without fatigue to the metal. A common cause of deterioration in the quality and strength of copper was its contact whilst hot with a reducing gas. These conditions caused a chemical change in the copper, rendering it brittle, and the effect could easily be produced on the brazing hearth by allowing the fire to be sluggish and short of the requisite amount of air-blast. Carelessness in that respect on the part of the workman was one of the most serious dangers copper had to meet.

Although copper had many virtues, as a material for the use of engineers, there were certain faults attaching to it. Amongst these were the following: For the conductivity of either electricity or heat purity was an advantage, but chemically pure copper had very little resistance to wear. Its ductility formed its most important advantage to the coppersmith and the makers of plates, tubes, rods, and so forth; but this ductility was

gained at the cost of a very low elastic limit. Notwithstanding the loss of strength resulting from subjection to high temperatures and to the action of certain gases, copper remained incomparably the best material for many purposes in the general practice of engineers.

THE TRANSMISSION OF POWER BY ROPES.

A VERY complete paper on the Transmission of Power by Ropes was read at a meeting of the Staffordshire Iron and Steel Institute by Mr. Edwin Kenyon.

Remarking that rope driving may be divided into two leading branches, known as the American or Continuous System, and the English or Individual System, the author carefully examined the relative value of each. He first dealt with the American or Continuous System—that of winding a long rope round and round the pulleys, and then carrying it from side to side as it completes the circuit, by means of a jockey pulley fixed at the required angle.

This system, it will be observed, necessitates a series of deflections from the straight driving path, causing the rope to assume the form of an elongated spiral, and setting up a one-sided pressure in the grooves until it (the rope) passes on to the arcs of contact. If the weight upon the "jockey" pulley is so arranged as to merely take up the slack and balance the driving tension of that part of the rope which it controls, then the frictional loss due to carrying the rope across the pulleys is not a very damaging factor; but when it is overloaded with a view to levelling up the entire drive, the strain, as may be imagined, is very materially increased, without accomplishing its object.

In order to understand better this method of driving, let us introduce ourselves to what was, up to a short time ago, one of the best examples on this side of the Atlantic, but which is now transformed to the single rope system

GRAIN ELEVATOR DRIVING.

In this instance the full load was transmitted from the engine to the main shaft by separate cotton driving ropes, and then conveyed to grain elevators by means of Manilla ropes, fitted up on the American system by the firm supplying the machinery. When in full action this continuous drive displayed a most interesting phenomenon, which offered rebutting evidence to the much-vaunted tension equality theory. Looking directly down the driving line, a distinct deviation from the presumed horizontal plane was observable along the whole width of the drive. At the commencement of its circuit the rope was seen to reach its highest tension, from which it gradually declined at regular intervals, marked by its passage from groove to groove, reaching its lowest point at the last lap, to renew and repeat the operation so long as it continued to work. When we take into consideration that the grooves form part of the driving pulley, and are not loose sheaves like those of a pair of blocks, it will be readily understood that the wedging action prevents any interference with the original tension at which the rope is fixed, save by the strain on the working side, unless the rope stretches unduly, or is made to slip, and that such a process would be fraught with loss of power.

Doubtless the greatest hindrance to the general adoption of the American system for all purposes is the fact that dependence has to be placed upon one rope; should

that fail, the driving must stop until it is replaced. With the separate rope system, an excess of the actual power required being usually provided, the replacement of a rope may await a convenient season, and that without detriment. We do not propose a wholesale condemnation of this system; there are circumstances where continuous rope driving may be adopted with advantage over other methods—for instance, in its application to paper-making machinery, and under other awkward conditions. An advocate of continuous driving recommends pulleys of not less than sixty times the diameter of the ropes.

THE INDIVIDUAL ROPE SYSTEM.

The author proceeded to discuss at length the considerations bearing upon the relationship of ropes with pulleys, under the conditions governed by the Individual System. He remarked that—

The absolute point of detraction in power from the employment of relatively small pulleys cannot, of course, be determined with mathematical accuracy, by reason of the elastic medium with which we have to deal, whose elasticity varies with almost every make of rope. We must, therefore, be content to declare a position between the extreme limit where the bending faculty of a rope ceases to exert its influence, and the radius controlling the highest capability with which we are acquainted. By reason of the great disparity in elasticity between cotton and Manilla, what is known as "permanent set" (i.e., where elasticity altogether ceases) being reached at a very much earlier stage in the tension of the last mentioned, is has been found necessary to fix the smallest pulley diameter at 50 per cent. greater than that of a cotton rope. For the efficient transmission of power, the smallest pulley used with cotton ropes should not be less than 30, and with Manilla 45 diameters, unless extra rope power is added to make up for loss of grip.

GROOVES.

The paper contained a number of useful suggestions as to awkward conditions of rope transmission, and some valuable information on the subject of grooves. The author described the latter as the most important item in the whole economy of rope transmission, at least so far as mechanical arrangements are concerned. Incidentally he remarked that—

At one time it was an accepted theory with many engineers that grooves should bear some resemblance to the rope itself, and therefore curved sides were introduced in the belief that they afforded a necessary element to the rope when leaving the grooves. When grooves of this description are employed we generally find it necessary to increase the diameter of the rope to the utmost limit, not only to make up for loss of power, but to prevent, as far as possible, the rolling action often induced thereby.

The angle at which driving rope grooves are constructed vary as much as from 54 degrees to 15 degrees, the latter being applied to the driving of cotton machinery with small bands, and from the results obtained it would appear that every diameter of rope has its most appropriate angle. While this need not be carried to the extent of providing a range of templates to cover all sizes, some line of demarcation between the acute and obtuse is advisable.

One firm of engineers works to four different angles, beginning with 30 degrees for small ropes, from $\frac{1}{2}$ in. to $\frac{3}{4}$ in. diameter, 36 degrees from 1 in. to $1\frac{1}{4}$ in., 40 degrees from $1\frac{1}{2}$ in. to $1\frac{3}{4}$ in., and 45 degrees from $1\frac{3}{4}$ in. to 2 in.

What we advocate is 30 degrees for all driving ropes under $1\frac{1}{2}$ in. diameter and 40 degrees for all above that size, including the 2 in. diameter. Indeed, from what we know of the working of $1\frac{1}{2}$ in. ropes in angles of 20 degrees, we have no hesitation in declaring our belief in the keener angle for all diameters, excepting the small machine bands. Acute grooves certainly afford a check against revolving action.

ADDRESS BY THE PRESIDENT OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

(Abstract continued.)

THERE were now established in Great Britain 13 two-phase and 5 three-phase stations, exclusive of power-transmission stations. In 29 cases supply was given on two or even more systems. Many of the alternating-current stations had taken up the supply of direct current, others had added two-phase or three-phase supply to their single-phase service, or had changed over completely to one of these. The direct-current system appeared to be in no immediate danger of supersession, in part owing to the raising of the voltage, and the consequent possible extension of the service area. The number of voltages in use was somewhat confusing, and presented to the Standards Committee a difficult problem to solve. These voltages now amounted to about 16, and out of 289 examples of pressures, nearly one-third were declared at 230, more than one-sixth were given as 220, while voltages of 240, 200, and 100 claimed about one-eighth each. There were between 50 and 60 stations which revelled in more than one declared pressure. The extent to which the change from one voltage to another had taken place might be judged from the fact that in 234 cases the pressure was upwards of 200 volts; 64 supply current both above and below 200, and there were only 29 whose supply was entirely under 200 volts.

Since the establishing of the Portrush electric tramway in 1883 the electrical engineer had encroached on the field of the tramway engineer, and, consequently, the purely tramway work, as apart from the electrical work, had often shown the mark of the active, clever, but untrained mind, impossible curves and grades being attempted, and unnecessarily expensive work being done. There had been some advantage in this, no doubt, as the experience gained by these works, although expensive, had tended to improvements in practice. There was an American manner in this mode of procedure which led to a free use of the scrap heap. The golden rule, "Be sure you are right, and go ahead," was the best to follow, but it often happened that one died and was taken from the arena before even the first part of the rule was complied with. On the whole, therefore, it was perhaps as well that chance should be allowed to play its part, and that activity and energy should not be troubled with a too severe bearing-rein. Already many of the paymasters were questioning the scrap-heap theory, as they knew by experience that this was often evolved from nothing but a craving for change and a want of appreciation of the true value of money on the part of their advisers. These remarks were made with no desire to convey the idea that work in this country was not carried out conscientiously and well, but rather with the view of suggesting a curbing of the expenditure of money which produced

a semblance for the moment of unbounded prosperity, while in reality it only meant riding full gallop for a fall. If the fall should occur, the many men who were entering the ranks every day and swelling the numbers would find their prospects blighted owing to a disturbance of the trust which was placed in the electrical engineers of to-day by those who supplied the sinews of war. Mr. Gray therefore thought it incumbent on every electrical engineer to carefully weigh every recommendation he might make, not from the point of view of immediate, but rather from that of ultimate efficiency, and to deal with every possible factor in drawing his estimates.

THE ELECTRIFICATION OF RAILWAYS.

The application of electric traction to our railways was progressing. At present the sections which were being dealt with were those which had a great traffic density or a frequent service. This policy was doubtless a wise one, as the railway companies limited the application of a considerable capital expenditure to the best paying division of their lines, and to those portions where the benefits to be derived were the most apparent. During the current year the first section of the Metropolitan-District Railway conversion had been made, and it was expected before March of next year that the Moorgate Street-Drayton Park and Drayton Park-Finsbury Park sections of the Great Northern and City Railway Company would be in operation. The Mersey Tunnel Railway had been completed, and the conversion of the Wirral Railway was under consideration. The North-Eastern Railway had had trial runs along Tyneside, and good progress was being made with the Liverpool-Southport line. The Central London Railway was completing the change from locomotive to motor-car driving. The motor-car system was generally accepted as the best form for passenger traffic for many reasons which need not be recapitulated. The direct-current system at 500 to 700 volts appeared to remain as a standard for railway work of this class, as well as for tramway work, but there were signs that single-phase alternating current might prove a rival. In the United States the Washington Annapolis Railway was being equipped with an overhead system, which would deliver direct to the motors a single-phase current at 3,000 volts. The three-wire system of feeding tramways and railways, though not without examples abroad, had not been adopted in this country save on the City and South London Railway, where it seemed to have proved satisfactory.

ACCUMULATORS.

Although accumulators were being extensively used for private carriages in London and elsewhere, yet this country had not seen its way to employ them for rail or tramways. In Italy and Germany some use was made of them, and it was stated that, as the result of two years' working on lines running out of Bologna, the cost of battery traction had proved 28 per cent. cheaper than steam. The use of storage battery locomotives in America for shunting and mine work appeared worthy of mention, as it seemed to have attained considerable proportions, and to have proved successful in practice.

The address also dealt with the growth of the Institution, touched upon some of the most notable electrical projects at present in progress, surveyed the status of submarine telegraphy, briefly reviewed the work of the Engineering Standards Committee and called attention to the present functions of electro-chemistry.

BOOKS OF THE MONTH.

"PRACTICAL CONSTRUCTION OF ELECTRIC TRAMWAYS."

By William R. Bowker, C.E., M.E. E. and F. N. Spon, Ltd. 6s. net.

An excellent treatise on electric tramway construction with numerous diagrams. The author's treatment being essentially practical, he at once dips into the question of laying out the permanent way. Chapter II. is devoted to the preparation of a substantial road bed foundation, without which, as the author points out, it is useless to expect reliable results. With the aid of numerous diagrams, he then describes the laying of the rails, plate laying, bonding, etc. As to the completion of roadways, the author notes that no pavement has yet been discovered with so long a life as granite sett pavement, properly laid with judiciously selected granite or syenite. There is a good deal of useful information anent wood-paving. The details connected with the overhead equipment are carefully considered, and the author includes notes and details on materials used in the construction of the Manchester, Brighton, Lancaster, and other well-known tramway undertakings. It is highly important and desirable to be able to localise faults in the tramway system, and a whole chapter is therefore devoted to the testing and maintenance of electric tramways. It is intended in the near future to increase the scope of the work, and to introduce some additional information relating chiefly to the slotted conduit system of electric traction, and also to electric, street, underground, and elevated railway systems. In the short space of 111 pages the author has given a most instructive view of the practical construction of electric tramways.

"WATER SUPPLY."

A Student's Handbook on the Conditions governing the Selection of Sources and the Distribution of Water. By Reginald E. Middleton, M.Inst.C.E., M.I.Mech.E., F.S.I. Charles Griffin and Co., Ltd. 8s. 6d. net.

The engineering student will here find an excellent compendium of the subject, in which special prominence has been given to such questions as the quality of water, the interpretation of analyses, the stability of masonry dams, the flow of water through pipes, and the general application of mathematics to the subject. Incidentally, the author calls attention to the fact that there are but few rivers and streams in England which are accurately and systematically gauged. One of the first questions to be answered in designing new water works is the amount of rainfall in the district under consideration, yet, notwithstanding the labours of Professor Symons, his successor, Mr. Sowerby Wallis, and others, the information obtained is far from perfect. The writer is strongly of the opinion that the utmost publicity should be given to all the knowledge which exists on the subjects referred to; but the work, to be complete, should not be directly in the hands of private individuals, but of conservators of the several drainage areas into which the country should be divided for purposes of the prevention of pollution of rivers and streams, water supply, and drainage. Their duty should consist in safeguarding

the waters under their authority from pollution, in utilising them to the best advantage both from a sanitary and economical point of view, and in preventing, so far as their powers extend, the wasteful and unnecessary duplication of small sewage disposal works. Finally, they should not only be empowered, but be under the obligation, to systematise the rainfall statistics within an area of each, to ascertain the flow of the main river under their charge, and each of its tributaries, to keep a record of the changes of level in a number of representative wells, and to publish within a reasonable time the whole of the information so collected. The towns, in like manner, should be obliged to afford to the conservators full and accurate information as to the extent of their drainage area, the rainfall in it, the water collected from it, the water supplied to the town, and its uses.

"THE HANDYMAN'S BOOK OF TOOLS, MATERIALS, AND PROCESSES EMPLOYED IN WOODWORKING."

Edited by Paul N. Hasluck, with 2,545 Illustrations and Working Drawings. Cassell and Co., Ltd.

This well-printed and illustrated work fully sustains its claim to be a practical book on practical handicraft in wood. Having described the various kinds of tools employed in woodworking, the author proceeds to easy examples of woodwork. In the subsequent pages he treats extensively of the further numerous applications of the handicraft, including outdoor, domestic, and office furniture. The volume teems with hints which should be useful both to the amateur and to the mechanic. There is a chapter on lathes, turning and turnery, and the utility of the work is greatly enhanced by a complete index.

"ACETYLENE: THE PRINCIPLES OF ITS GENERATION AND USE."

By F. H. Leeds, F.I.C., F.C.S., and W. J. Atkinson Butterfield, M.A., F.I.C., F.C.S. Charles Griffin and Co., Ltd. 5s. net.

Acetylene has latterly found such an increasing use that this work—a practical handbook on the production, purification, and subsequent treatment of acetylene for the development of light, heat and power—makes an opportune appearance. It is a comprehensive treatise and is to be strongly recommended to those who are making a study of the subject. The special aim of the author has been to explain the various physical and chemical phenomena: (1) accompanying the generation of acetylene from calcium carbide and water, (2) accompanying the combustion of the gas in luminous, or incandescent burners, and (3) its employment for any purpose—(a) heat, (b) compressed into cylinders, (c) diluted, and (d) as an enriching material. There are many useful tables, one of the most interesting giving the cost per hour of lighting respectively by acetylene, petroleum (paraffin oil), coal gas, candles and electricity.

"THE WONDERFUL CENTURY."

The Age of New Ideas in Science and Invention. By Alfred Russel Wallace. Swan Sonnenschein and Co., Ltd. 7s. 6d. net. New edition, revised and largely re-written, with 107 illustrations.

This very interesting book for occasional reading, has been improved by the omission of a long dissertation on vaccination. In place of this, notes have been added on locomotion by land and sea, photography, engraving, chemistry, electricity and astronomy. In a work in which so much has been attempted there is necessarily a good deal of superficiality, but enough is said of the various subjects to stimulate interest and to open the way for further study. This superficiality for instance is particularly noticeable in the section dealing with wireless telegraphy. The half-tone illustrations are not a strong point.

"THE ELEMENTS OF ALTERNATING CURRENTS."

By W. S. Franklin and R. B. Williamson. Second edition, re-written and enlarged. Macmillan and Co., Ltd. 10s. net.

In this work the principles of alternating currents, and the theory of the various types of alternating current machinery, have been rendered as intelligible as possible to the student. Five chapters have been added covering the ordinary types of alternating current apparatus, and showing the conditions under which it is operated; these are intended to be read in connection with the theoretical sections of the work. The numerous additions include a complete series of practical problems with answers, and especially noteworthy are the alterations in the chapters on the alternator, the transformer, the synchronous motor, the rotary converter and the induction motor.

"ELEMENTARY TELEGRAPHY AND TELEPHONY."

By Arthur Crotch. With numerous illustrations. E. and F. N. Spon, Ltd. (London) and Spon and Chamberlain (New York). 4s 6d. net.

One of the Finsbury Technical Manuals edited by Professor Silvanus P. Thompson, D.Sc., B.A., F.R.S., M.I.E.E., etc., this work is intended to give the student in this special field a thorough grounding in leading principles. Its scope will be sufficiently indicated by the following synopsis of contents: Magnetism; terrestrial magnetism—magnetic theory; static electricity; electrostatic induction—condensers; dynamic electricity—the voltaic cell; primary and secondary cells; resistance, current and electromotive force; effects of current—galvanometers; induction; cross-section—combined resistances; joining-up of cells—universal battery system; telegraphy; single needle—sounder; relays—double-current working, etc.; Wheatstone A B C—Stelje's recorder; differential duplex; bridge duplex; submarine; the telephone; telegraph and telephone lines; elements of testing. The treatise is well printed and illustrated; great care has obviously been expended in its production, and owing to its concise arrangement it should save the student of telegraphy and telephony considerable trouble in getting at the elementary facts of the subject,

"THE PRACTICAL ENGINEER POCKET-BOOK FOR 1904."

Technical Publishing Company, Ltd., Manchester. 1s. net. Leather gilt, with diary on ruled section paper, 1s. 6d. net.

An astonishing amount of information for ready reference in small compass has been included in the sixteenth annual edition of this pocket-book. It has been revised and brought up to date, and should be in the hands of every practical engineer. Among the illustrations and additions may be mentioned a description of the water-tube boiler of the Stirling Company of U.S.A., the Daimler motor and the notes on patents and patent law.

"THE PRACTICAL ENGINEER ELECTRICAL POCKET-BOOK AND DIARY, 1904."

Technical Publishing Company, Ltd., Manchester. 1s. net. Leather, gilt, with diary on ruled section paper, 1s. 6d. net.

On similar lines to the above, this useful auxiliary has now reached its fifth annual edition. It includes this year the standards of electrical conductors, as recommended by the Cable Makers' Association, some additional facts in reference to conduit wiring, and some new types of electrical instruments.

"ELECTRICITY AND MAGNETISM."

An Elementary Text-book, Theoretical and Practical. By R. T. Glazebrook, M.A., F.R.S. Cambridge University Press. 7s. 6d.

Presents the A B C of electricity in numbered paragraphs, and offers the young student a good grounding in the subject. Between the time-worn experiment with a pith ball on the first page, and the observations on the electron theory of matter which concludes the work, many experiments are given and lucidly explained, while the student can test his progress by means of carefully arranged examples, to which answers are furnished at the end of the volume.

"BROWN'S COMPREHENSIVE NAUTICAL ALMANACK."

Harbour and Dock Guide and Advertiser, and Daily Tide Tables for 1904. James Brown and Son (Glasgow). Simpkin, Marshall (London). 1s.

This handy work of reference has a full digest of the astronomical and other phenomena required for the purposes of navigation; complete list of lights, fog signals, beacons, and buoys on coasts of the United Kingdom, with lights and fog signals in the Baltic and North Sea, etc. The publishers have, in this edition, for the first time given the tidal constant for every port of Great Britain and Ireland, with the depth on sill of every dock and harbour, as well as an elaborate table of tidal constants.

OUR DIARY.

November.

23rd.—Labour riots and strikes reported from America.—President Roosevelt receives Lord Lyveden and Dr. S. Lunn who are arranging an English Parliamentary visit to the St. Louis Exhibition next autumn.—International Sanitary Conference concludes its meetings at Paris—the establishment of an International Sanitary Bureau in Paris not agreed upon, several of the Powers being opposed to the scheme.

24th.—The Royal Commission on Coal Supplies resumes its sittings.—Death of Mr. Siegmund Loewe, a director of Messrs. Vickers, Sons and Maxim, consequent upon injuries sustained in a motor-car accident.

25th.—Annual dinner of the Institution of Mining and Metallurgy—speech by Sir W. Anson, M.P.—Inventions Exhibition opens at Brighton.—Representatives of both Houses of the British Parliament visit Paris.—Death of Mr. William Cochrane, coal owner and ironmaster, of Newcastle.

26th.—Issue of Parliamentary paper containing abstracts of the returns made to the Board of Trade of shipping casualties on our coasts during 1901-2.

27th.—The majority and minority reports of the Native Labour Commission published at Johannesburg.—Mining accident at Grassmoor Colliery, near Chesterfield.—An electrical department, distinct from all other departments, organised in the Devonport dockyard.—Mr. C. Salter lectures at the Liverpool University on "Ankylostomiasis in Mines."

28th.—The Great Western Railway Company announce that they will proceed immediately with their scheme for the construction of a new harbour at Weymouth.—The Highways Committee of the London County Council issue its regulations under the Motor Car Act, 1903.—Settlement of the colliery strike at Acton Hall, Yorkshire, which caused 2,000 of Lord Masham's employes to be out of work.

30th.—Great distress reported from Cape Colony owing to the arrival there of large numbers of people for whom no work can be found.—Death of Sir Frederick Bramwell.—Anniversary meeting of the Royal Society.

December.

2nd.—Mr. Wybergh, the Commissioner of Mines in the Transvaal resigns.—Labour troubles reported from the United States—it is announced that employers in every branch of building industry will meet in convention for the purpose of organising a national association to fight against the demands of labour.—The Automobile Club decides to form an association for motor and van users, its object being to represent the views of motor and van users before the Local Government Board, and to resist undue restrictions, etc.

3rd.—The British Admiralty purchase the two battleships constructed at Elswick and Barrow for the Chilean

Government.—Second-class cruiser *Flora* goes ashore at Denman Island, and is likely to prove a total loss.—An anonymous donor presents £50,000 to the London University College "for the promotion of higher scientific education and research in that institution."

4th.—The Chamber of Trade, meeting in Johannesburg, passes a resolution affirming the necessity of imported coloured labour under restrictions.—The *Times* learns that an agreement for the amalgamation of their Mediterranean-American services has been concluded between the White Star and Hamburg-American Lines.

5th.—A deputation waits on the Lieutenant-Governor of the Transvaal to urge the desirability of a *referendum* before legislation is passed dealing with the importation of Chinese labour.—Serious railway accident on the London and North-Western line near Penrith.—Launching at Belfast of a new Union Castle liner, *The Kenilworth Castle*.

7th.—The session of the Legislative Council opens in Pretoria. The Lieutenant-Governor remarks that the Council will be asked to discuss whether it is advisable to supplement the supply of labour available in Africa by the importation of indentured labour.

8th.—Members of the Johannesburg Stock Exchange unanimously pass a resolution urging the Government to authorise the importation of coloured labour—there is good authority for stating that China is not opposing the scheme for Chinese coolies.

9th.—Institution of Electrical Engineers hold their annual dinner.

10th.—The Automobile Club Committee, on the recommendation of the judges, award the medals for the "Reliability" trials held in September.—Motor Car Exhibition opens in Paris.—The Institution of Electrical Engineers celebrate the tercentenary of the death of Dr. Gilbert, of Colchester—presentation made by the Institution to the Borough of Colchester of an historical picture representing Dr. Gilbert showing his experiments to Queen Elizabeth.

12th.—A deputation from the Labour Importation Association wait upon the Lieutenant-Governor of the Transvaal urging the immediate settlement of the question of importing labour.

14th.—Dynamite outrages reported from New York in connection with the building trades' dispute.

15th.—Members of the Johannesburg Stock Exchange demand the immediate settlement of the labour question.

16th.—The Royal Commission on coal supplies meet at Westminster—it is stated that the coal tax has adversely affected trade.

17th.—A public meeting in Pretoria resolves that the question of importation of labour should be deferred until there is a Representative Government.—Launching of the new twin-screw steamer *Durham Castle*.

NEW CATALOGUES & TRADE PUBLICATIONS.

Messrs. Mather and Platt forward two well-printed catalogues, which should be obtained by those who are increasing their power plants. The larger one sets forth the advantages of their two Cycle Gas Engines, including perfect scavenging with cool, fresh air, absence of heavy exhaust valves, and removal from the power cylinder of up and down strains due to the resultant of impulse and resistance on the crosshead pin, which in this case is entirely outside the cylinder. Emphasis is laid on the steadier running which results from an impulse at every stroke. The firm claim that they can obtain as high a degree of cyclic regularity, without the aid of excessively-heavy flywheels, as can be got with the best design of steam engine.

The other pamphlet is designed for those who require dynamos of smaller output than those included in the Multipolar Dynamo Catalogue. A range of twelve machines have been designed to meet this want. The three smallest sizes are of the two-pole type; all the larger machines have four poles. In all of them the steel magnet yoke constitutes a casing, with which the pole pieces are cast in one.* This constitutes an efficient protection entirely surrounding the armature, while forming a neat, compact design.

T. Weaver and Co., 22, Rosoman Street, Clerkenwell.—From this firm we have received two mounted sheets suitable for hanging on the wall, giving diagrams of their various ebonestos switch-handles and bushes. These are very clearly arranged for reference, and are drawn full-size. Particulars of prices are obtainable from auxiliary sheets. The arrangement is certainly a very commendable one, as it enables the eye to take in a comprehensive view of the products of the firm, such as would be impossible in the pages of a catalogue.

United Telpherage Company.—From this company we have received a number of circulars, post-cards, etc., illustrating their Telpherage System. One of these is devoted to the electrical handling of miscellaneous freight. The following are given as the most obvious advantages of telpherage in handling freight: No *ground or floor* space is required, the tracks being equivalent to a second story; no *drays* are used on or *between the tracks*; *lifting, and re-handling* are reduced to a *minimum*; the loading and unloading are done so rapidly that not only can much of the congestion now noticeable in all important freight yards be avoided, but it is also possible by Telpherage either to *double the capacity of any freight yard* or to *decrease its size by one-half*; smaller *storage stations or sheds* will be *adequate*, since there will be little delay in sorting the freight and removing it for distribution: the load, whether in the form of boxes, barrels or buckets, can be *deposited just where it is needed*, *Hand tiering* will be *avoided*, as will also the *slow, laborious lifting of box upon box or barrel upon barrel*.

William Mills and Co.—An illustrated list of aluminium castings, this being a leading speciality of the firm. The illustrations of castings made for motor cars, engines, etc., are most effectively shown by the employ-

ment of black backgrounds. An official report of tests of "Mill's" aluminium alloys, made at the Engineering Laboratory, Durham College of Science, is appended.

Westinghouse Brake Company, Ltd.—An illustrated booklet giving a complete description of the Westinghouse Electro-Pneumatic Signalling System. In a pamphlet issued last year attention was called to the advantages of the system, and an account was given of some notable applications. The present description of underlying principles is supplementary to last year's pamphlet, and is illustrated throughout with excellent half-tone blocks.

Brett's Patent Lifter Company, Ltd.—This company has issued a pamphlet which should be obtained by all interested in drop-forging. The working of their patent steam drop stamps is carefully explained with the aid of numerous half-tone illustrations, a prominent feature being three full-page plates illustrating batteries of drops on this system, installed at Crewe Locomotive Works. There is an interesting extract from articles by Mr. J. G. Horner on Die Forging, and the latter part of the pamphlet is devoted to Power Presses for all trades.

United States Metallic Packing Company, Ltd.—A particularly novel calendar has been issued by the United States Metallic Packing Company, Ltd., of Soho Works, Bradford. This has a large medallion in bas-relief, and a highly artistic colour scheme has been introduced, which is worth a much longer description than we can attempt in the limited space at our disposal. We would suggest that those interested would write to the Company for a copy of this calendar, and it will probably be found advantageous to write early.

The British Thomson-Houston Company, Ltd.—Pamphlet No. 162 is devoted to Automatic Circuit Breakers and is available for binding in the excellent cover provided for the purpose by the firm. The pamphlet points out that circuit breaking devices tend to draw an arc at the last point of contact, which, unless proper precautions are taken, ultimately renders them unfit for use. If such arcing takes place on the main contacts it will rapidly burn them and destroy the contact surfaces. It is therefore essential to break the arc away from the main contacts either by the provision of secondary contacts which open circuit slightly later than the main contacts, or by forcing the arc on to portions of the contact pieces, which do not form part of the contact surfaces. To reduce the destructive action to a minimum the arc should further be disrupted as rapidly as possible. In the Type M Circuit Breakers of the British Thomson-Houston Company the above requirements are met by the use of the magnetic blow-out. The larger sizes are provided with auxiliary contacts situated in a magnetic field, which disrupts the arc as soon as it is formed, while in the smaller sizes the magnetic action drives the arc on to special arcing tips and then instantaneously disrupts it. In the Type C Circuit Breakers secondary contacts are provided with a quick-break action, and are easily renewable.

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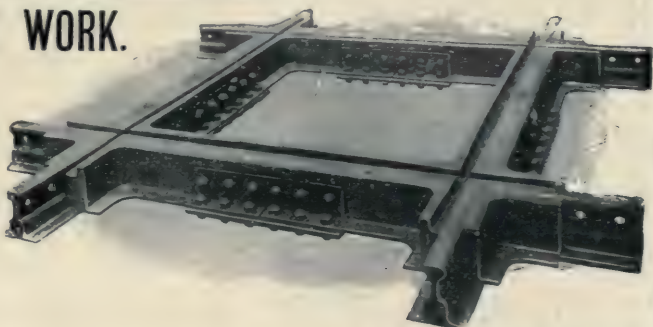
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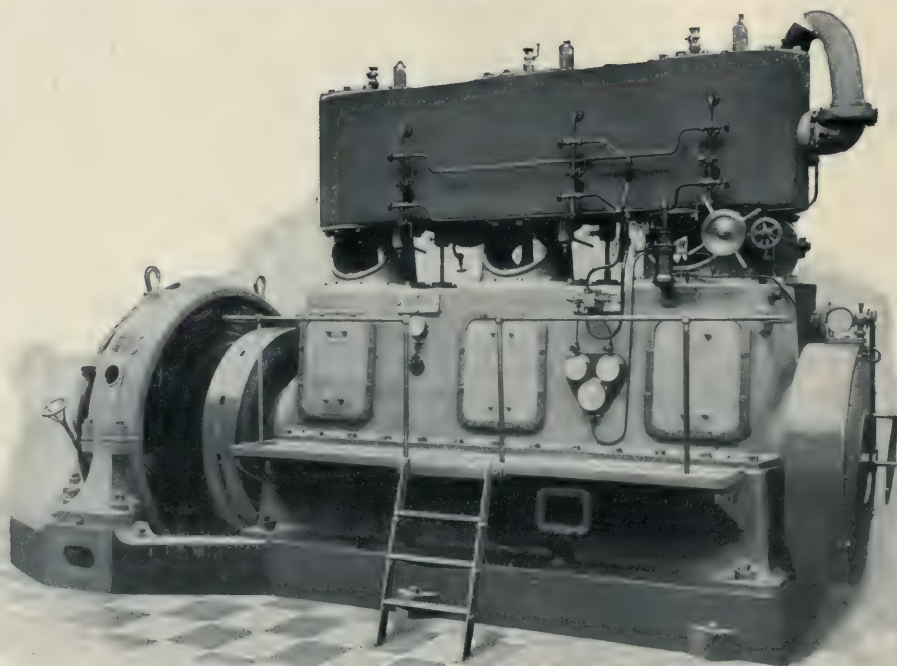
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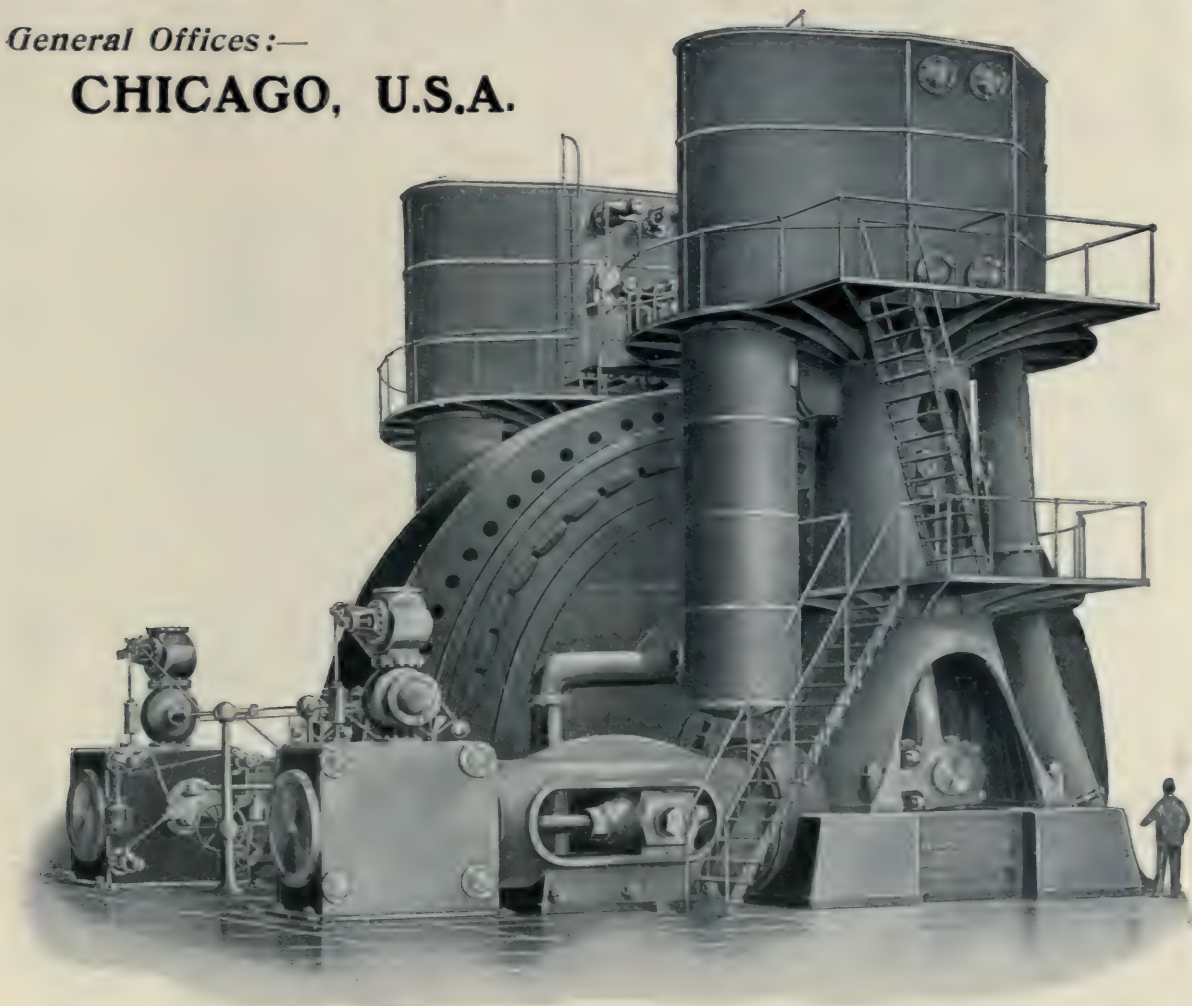
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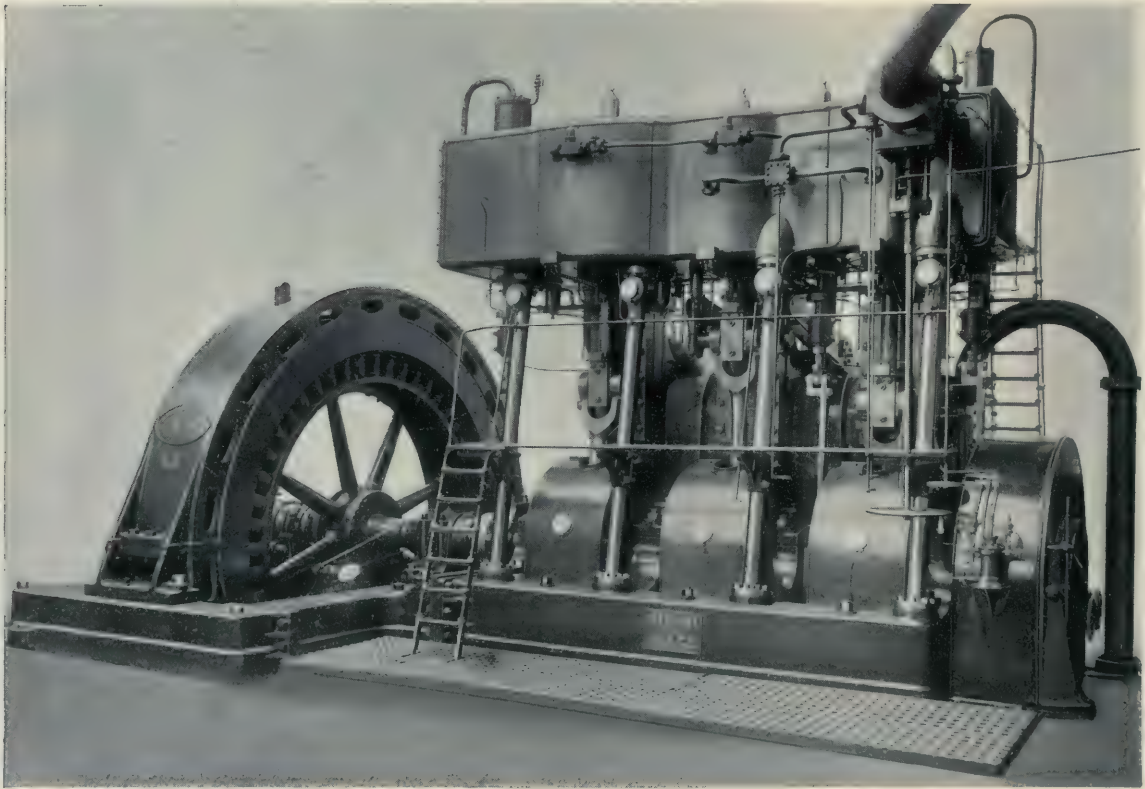
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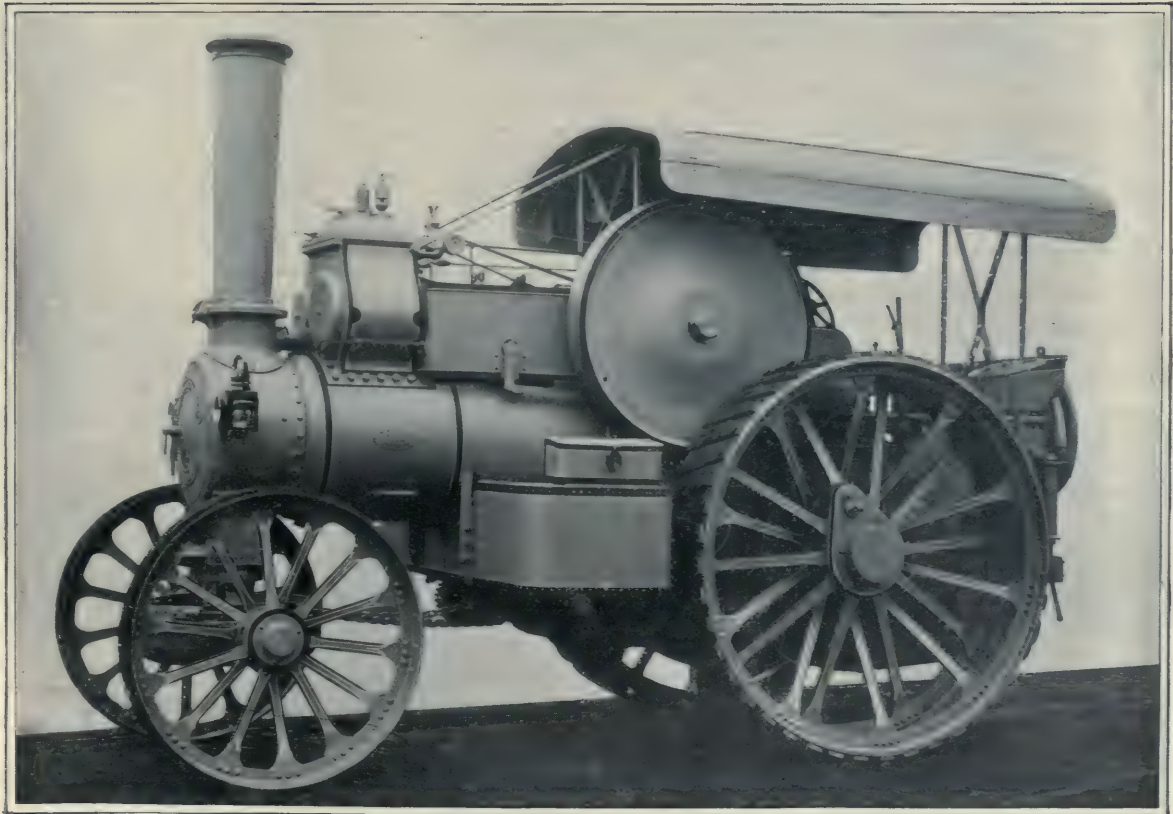
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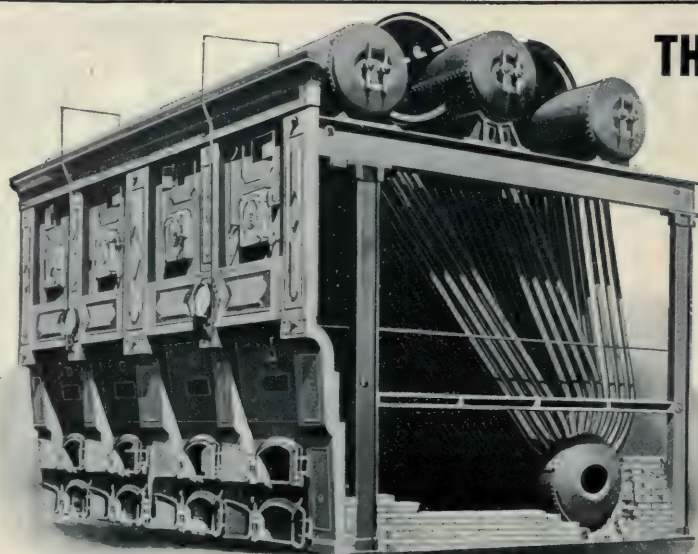
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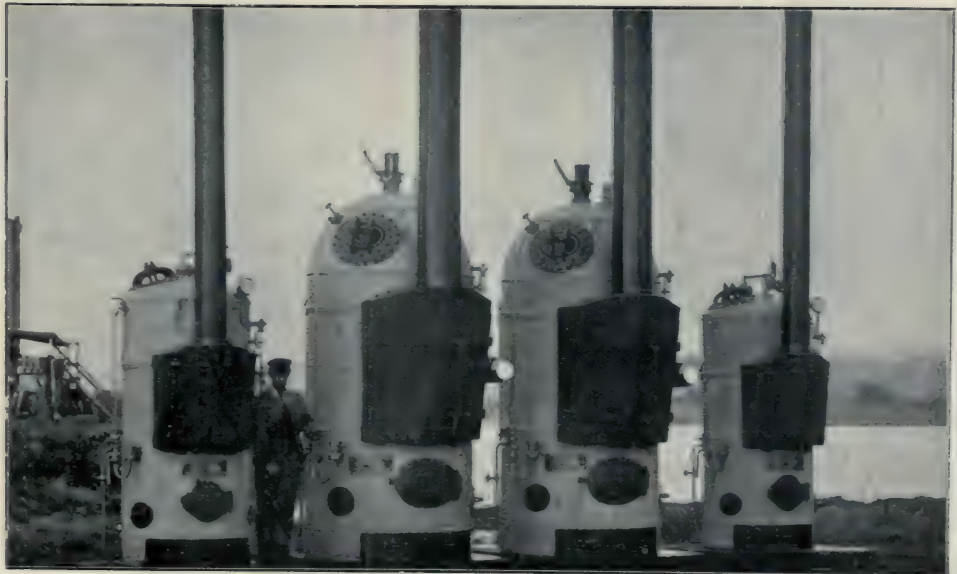
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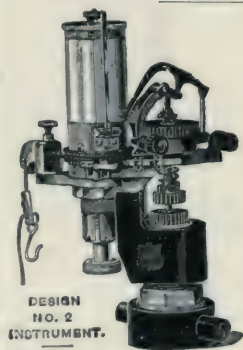
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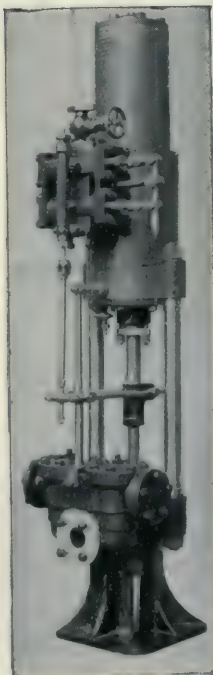
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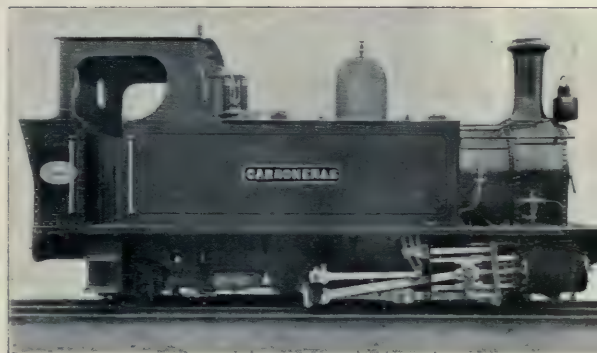
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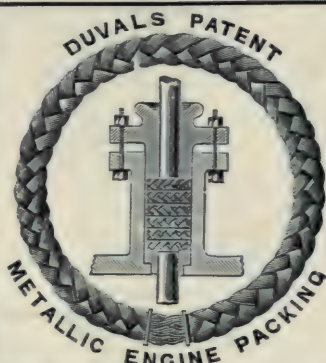
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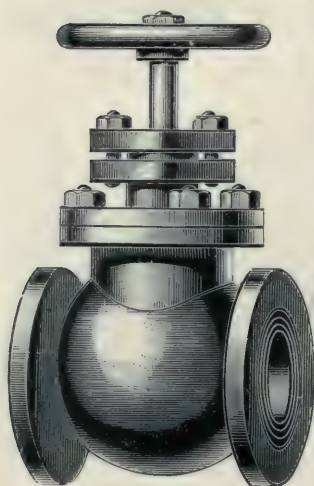
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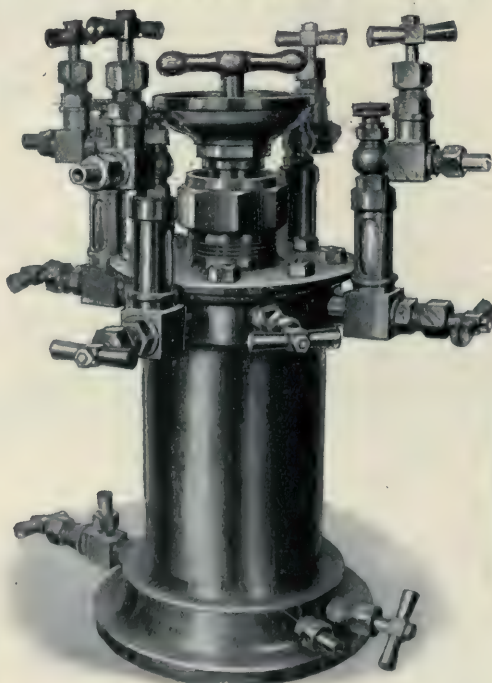
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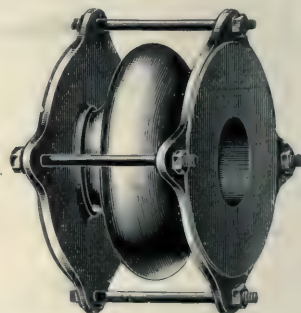
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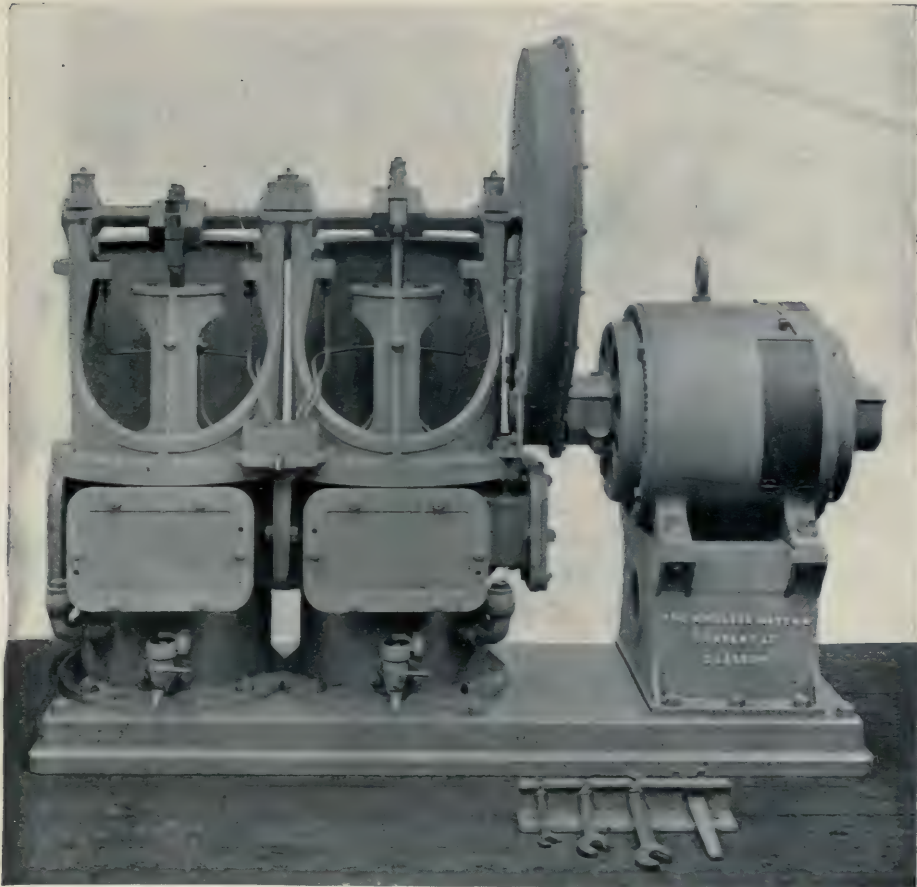
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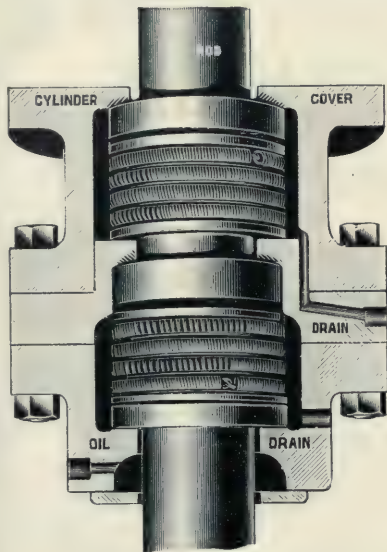
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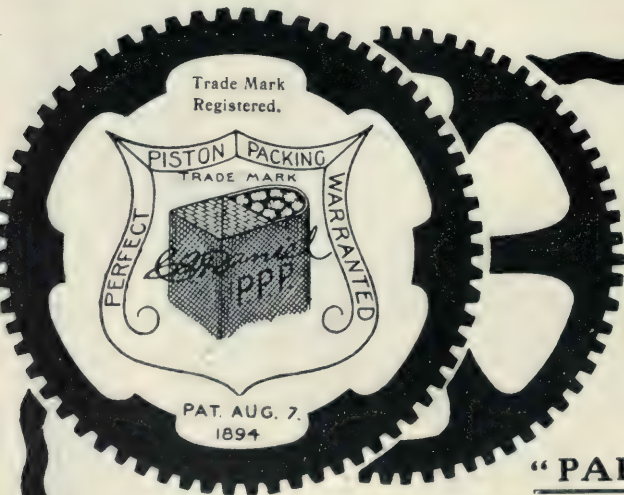
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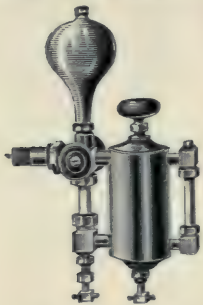
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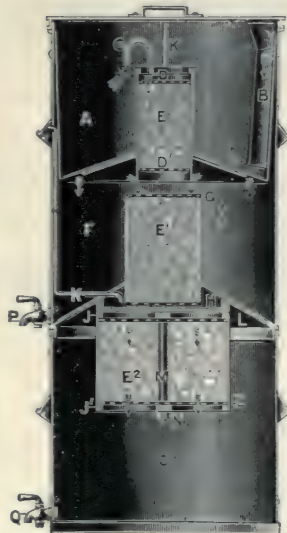
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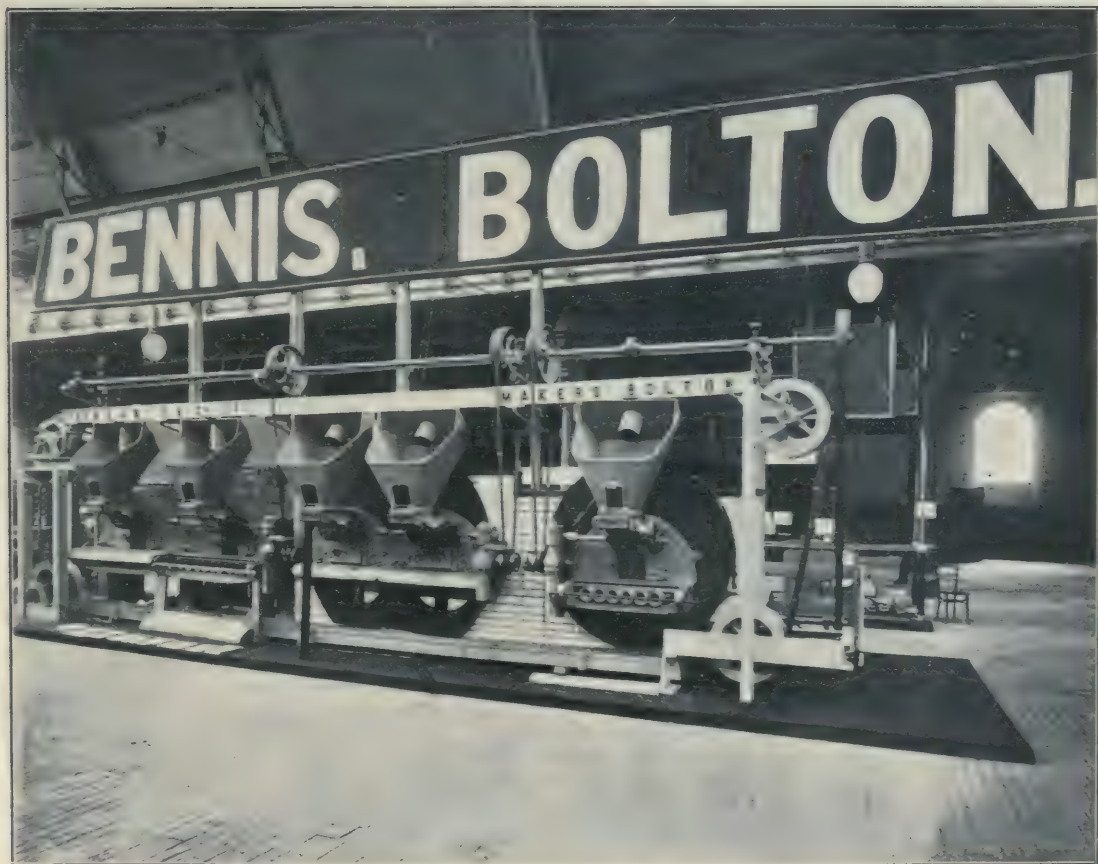
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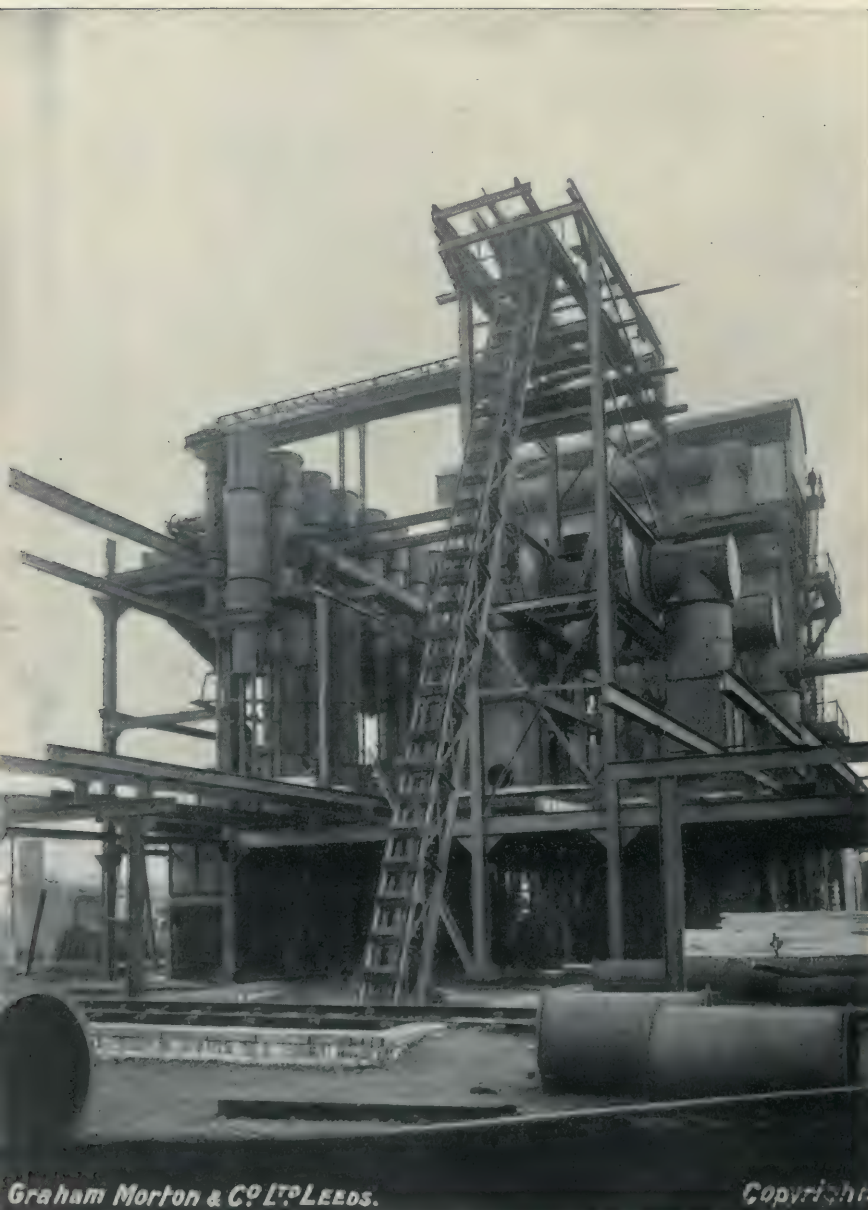
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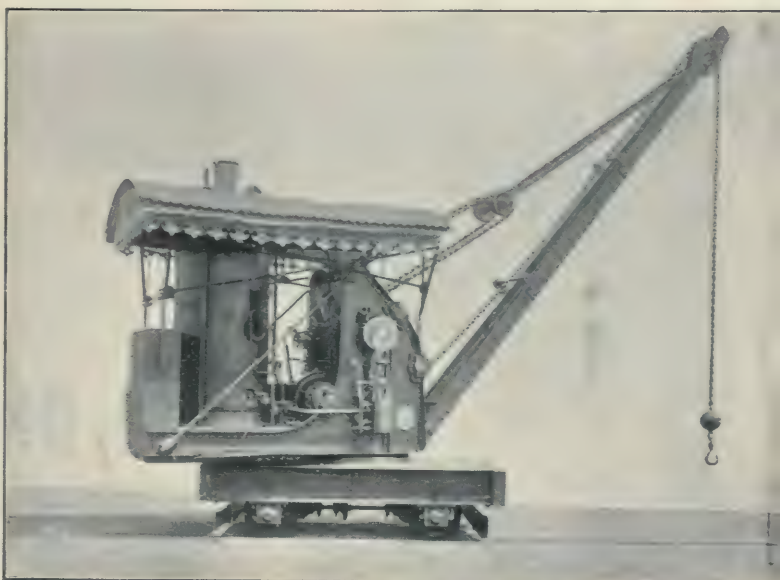
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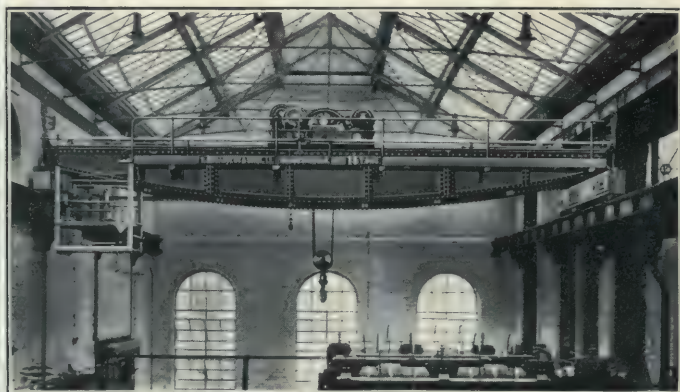
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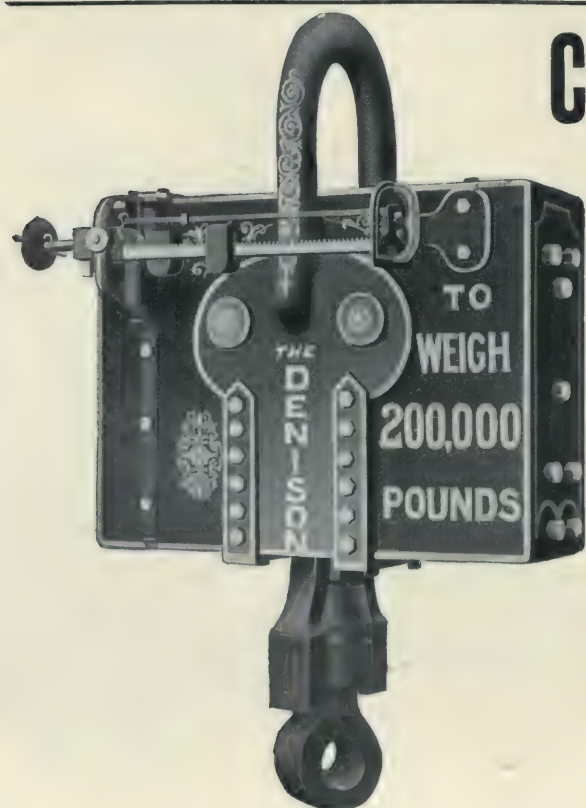
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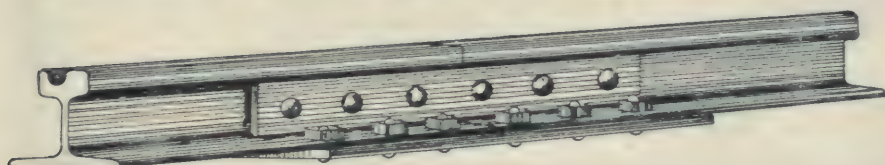
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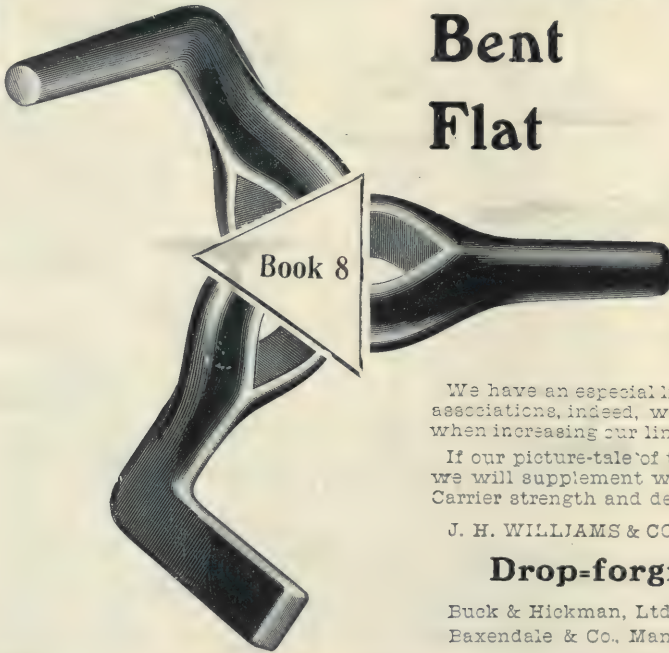


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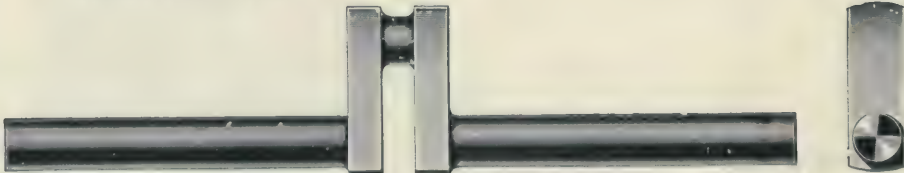
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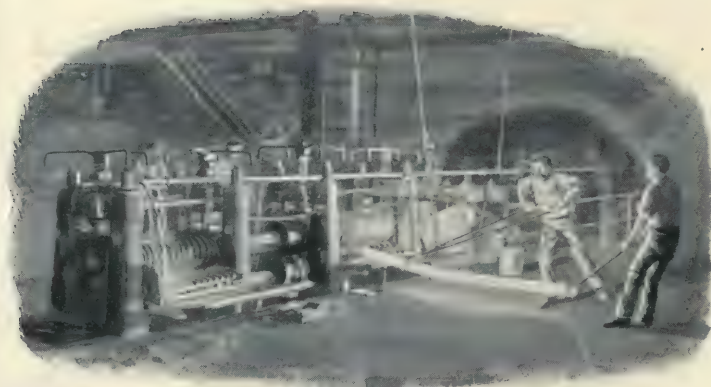
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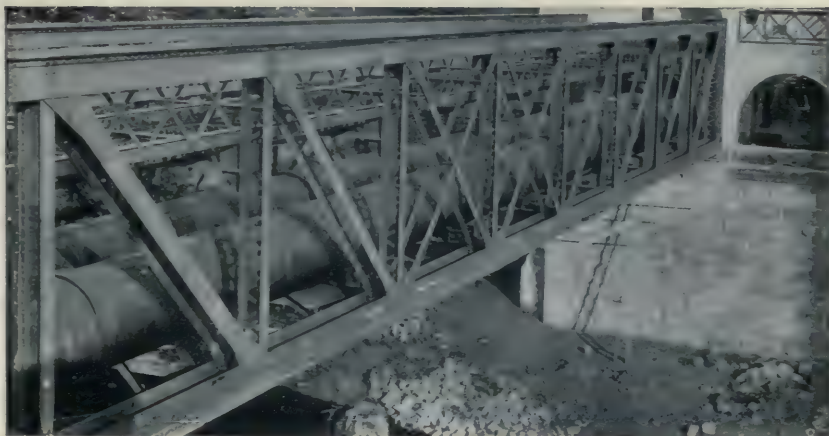
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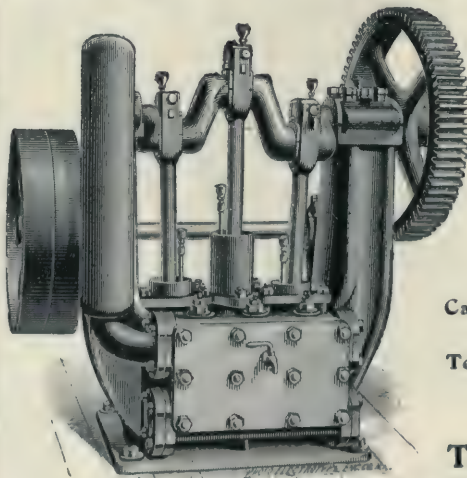
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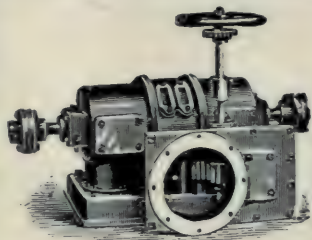
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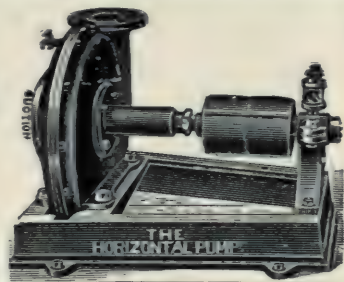
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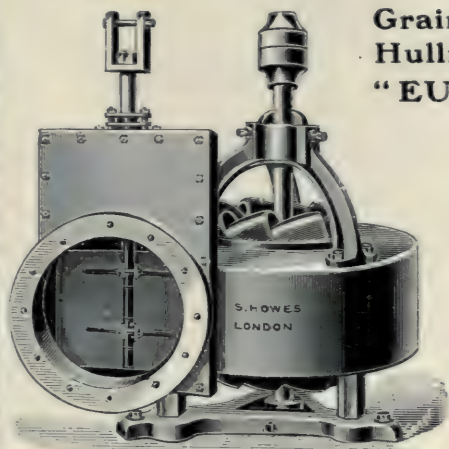


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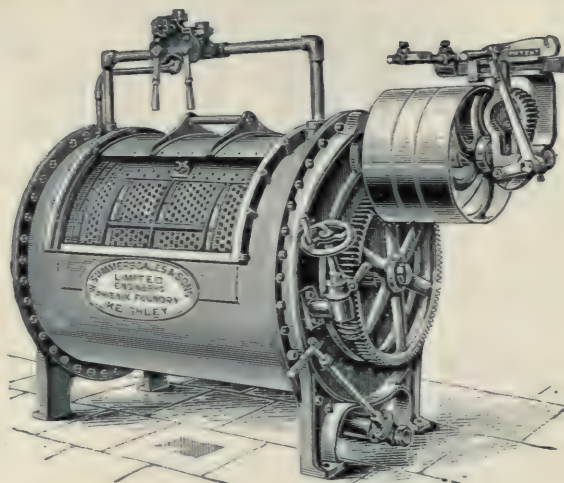
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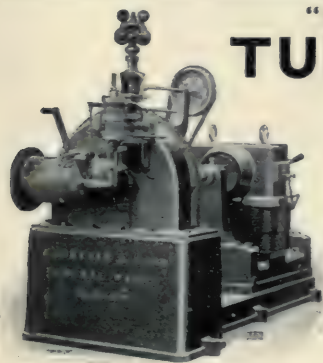
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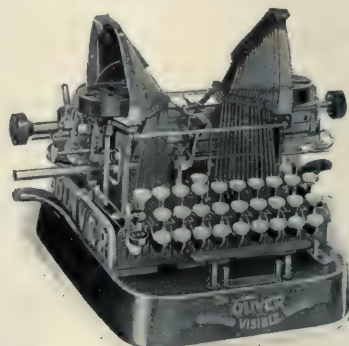
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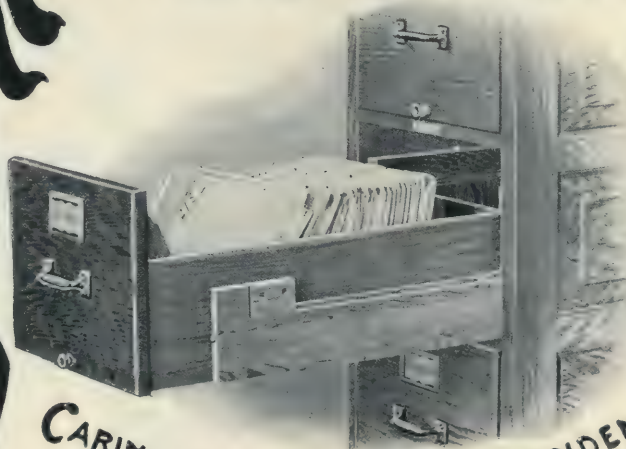
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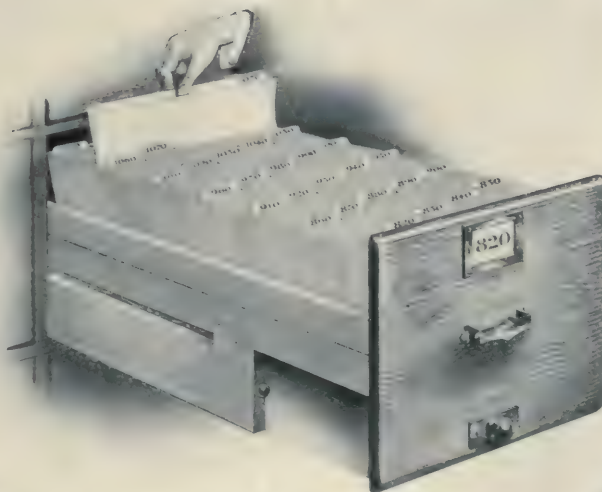
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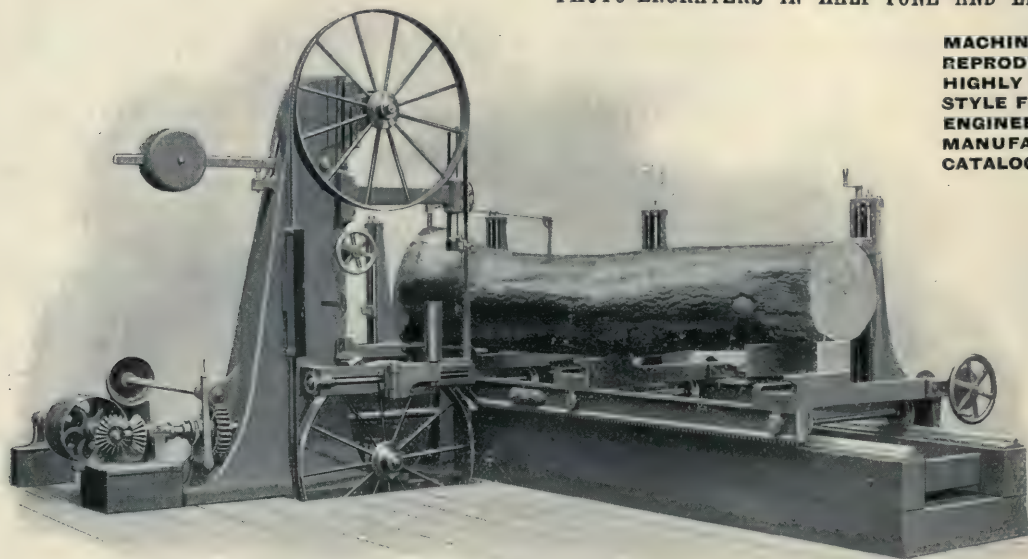
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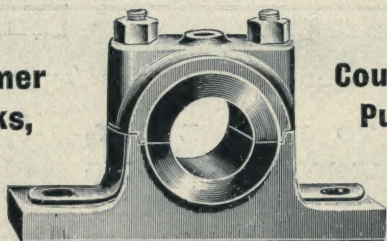
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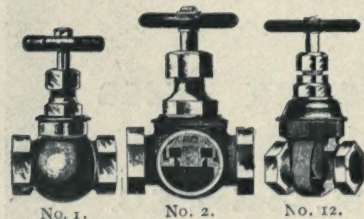
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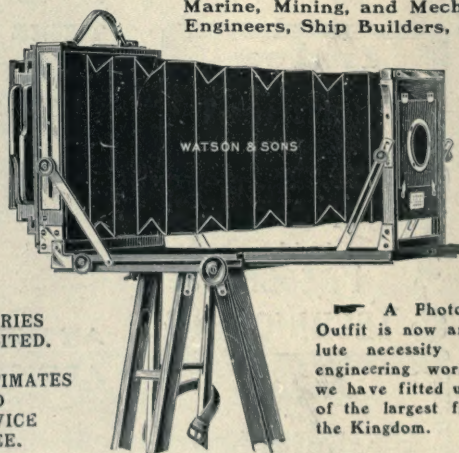
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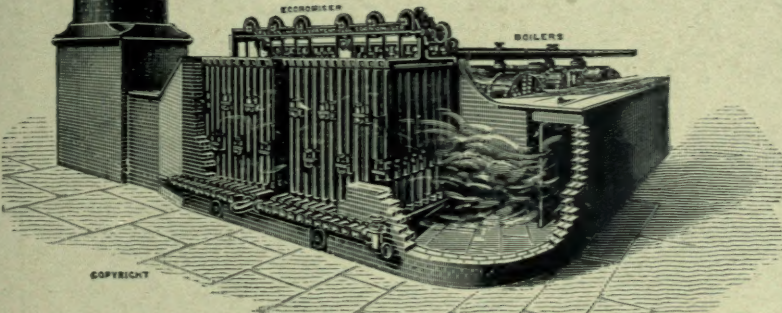
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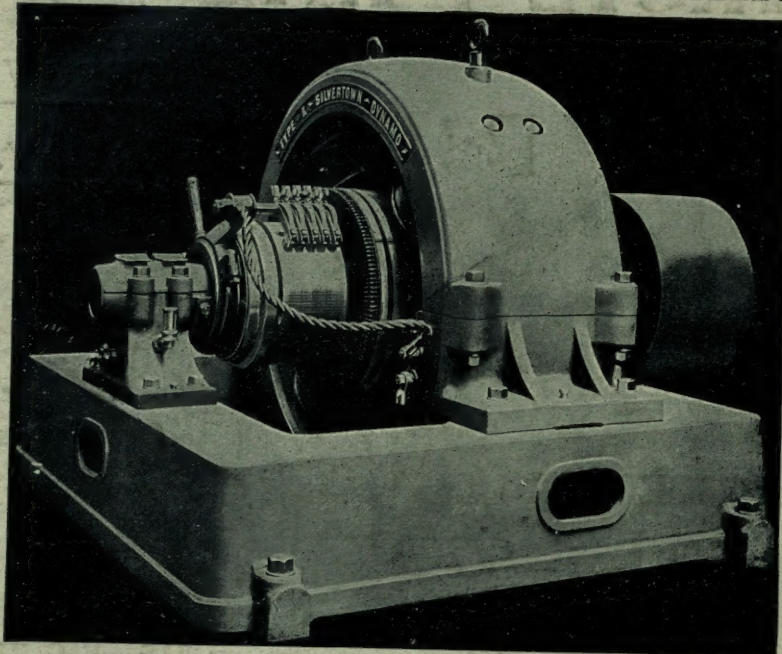
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